miles, and stores an important amount of water. From morning until about 2 o'clock, at which time the water used at Ware reaches this point, this pond has to supply the mills during low stages of the river, and is thus liable to be drawn down about 3 feet. The night-flow of the stream is ponded here for about two months in a very dry season, but in some years there is, throughout, a waste over the dam at night. The ordinary spring-freshet rise on the dams is in the neighborhood of 3 feet. The large upper pond holds back ice through the winter, and long enough so that it usually becomes well rotted before going out. Occasionally gorges form in the river below Thorndike, and cause backwater there temporarily; in extreme cases the river has even been set back into the mill and a stoppage of work forced.

From Thorndike to Ware, a distance of 7 miles, the valley is open and the stream bordered by narrow meadows. The statement was made, on not very good authority, that at some point below Ware a privilege with 15 feet fall is claimed, but this section of the river is generally described as flat and presenting little opportunity for the use of power.

At Ware the character of the stream changes for a time, and within the limits of the village it descends about 70 feet over rock ledges. The lowest privilege is occupied by the George H. Gilbert Manufacturing Company, which has also two large mills above at Gilbertville. The dam here is a low framed structure, running diagonally across the river, and giving a fall of 7 feet at the mill. The manufacture at the latter comprises fine flannels, soft woolens, and blankets, and 7 sets of cards are run.

Above this privilege the Otis Company has two dams, three falls, and three large mills. The upper dam runs across a rocky gorge, and has an extreme height of 30 feet. The roll-way is 117 feet long, 30 feet wide at the base and 6 feet at the top; the face is nearly or quite vertical. The dam is built of granite in cement, and on either side is dovetailed into the solid rock. A race 1,000 feet, more or less, in length conveys water from the bulkhead to the upper mill, where 400 (*a*) or more horse-power is in use, under 28 feet fall. The tail-water from the upper mill is carried by a short race to the second mill and is then discharged into the river. At this mill a fall of 19.3 feet and something over 200 horse-power are in use. The water thus far used, having been returned to the river, is held by the second dam, and on the north side furnishes 121 horse-power, under 16.3 feet fall, to the Otis Company's lower mill, and on the south side of the river is utilized by Messrs. C. A. Stevens & Co., manufacturers of flannels and dress-goods. As already stated, the Otis Company has large works at Three Rivers. At Ware it manufactures mainly denims, ticks, and checks, but also runs an important portion of its works on hosiery. In the mills here are operated 32,750 spindles and 662 looms, and employment is given to 1,450 hands.

The supply of water is commonly sufficient for running the mills at full capacity throughout the year, and during the trying summer of 1882 there was a slight shortage for only eight days. All the improvements at Ware are of the most substantial nature, and especially so on the premises of the Otis Company. The mills are of stone or brick, and on the company's grounds the races are walled with granite masonry.

Between Ware and Gilbertville, 4 miles, the river is bordered by flat meadows, and the fall is said to be too small to admit of a water-privilege.

At Gilbertville all the fall is owned by the George H. Gilbert Manufacturing Company. The same kinds of goods are made as at its mill in Ware; 31 sets of cards are run and 550 hands employed. The lower privilege, as at present improved, embraces 14 feet fall, which can be increased 6 or 8 feet by extending a moderate distance down stream. This privilege is not for sale, but power is rented to N. G. Reed for a box-shop and a small grist-mill. The two succeeding falls above, of 18 feet and 20 or 22 feet, respectively, are used by the Gilbert company, furnishing to two mills an aggregate of about 600 horse-power. The river-bed in this vicinity is mainly composed of gravel and bowlders. The immediate valley is rather narrow, and the village is very prettily located on rising ground. The pondage above the lower dams is small, but the upper dam sets the river back a long way and affords a good storage. Still farther up the stream is said to continue quite flat on to the Hardwick paper-mill privilege, but no examination was made above Gilbertville, 14 miles from the mouth.

The Swift river.—The Middle branch of the Swift river has its source in North pond, in the town of Orange; running southerly, it is joined, a mile or two above Enfield, by the East branch, and again, a couple of miles below the village, by the West branch. The distance, by river, from North pond to Three Rivers is 30 miles. The total area drained is 209 square miles. The stream is considered to be quite uniform, well sustained in summer, and well suited to manufacturing. So far as could learned there are no storage reservoirs for use during the dry season, although it is said that they could be built without much difficulty; but there are a number of natural ponds in the basin, and above Enfield the Middle branch frequently spreads out, and so forms a chain of several ponds along its course. The country drained, by the Middle branch at least, is hilly, and tolerably well wooded with a young growth of timber.

The first water-privilege above Three Rivers, on Swift river, is at Barrett's Junction, about 2 miles from the mouth, and is owned by the Barrett's Junction Water Power Company. The dam is about 120 feet long between abutments, 10 feet high, and was built in 1881 at an approximate cost of $5,000. It rests on rock, and is built up as a log crib-work sloping each way from the top. It sets the river back for about half a mile, giving a very good

a The falls at the two upper levels have recently been changed somewhat, but with the old fall of 25 or 26 feet at the first level, the wheels were rated at a total of 389 horse-power.

storage. A long canal runs from the vicinity of the dam, cutting somewhat across a bend of the stream and leaving room in between for mills. Near the lower end of this race a small side canal carries water to a wheel from which, by wire cable, power is transmitted several hundred feet across the river to the works of the Springfield Soapstone Company, which rents 125 horse-power.

The fall on this privilege is 20 feet, and the available power is estimated by the water-power company at 500 horse-power in a low stage of the river. The company owns 65 acres of land in the bend of the river, said to be level and well suited for sites for mills and a village. The dam, canal, and land have cost about $20,000. The company wishes to sell its land and lease the power; the rental charged the Springfield company, and which would probably be the same for other concerns, is about $9 per horse-power. A short distance below the dam Jabish brook, quite an important little stream, empties into the river. The design is to build another dam below the mouth of this brook, and then to use its water and the waste from the upper dam to run the soapstone works, leaving the whole power from the main canal still for rental. The New London Northern railroad proposes to cross the river on a bridge for which the abutments of the new dam shall serve as supports, and to run conveniently through the company's property. The power available here may be estimated as follows:

Estimate of power at Barrett's Junction.

Stage of river.	Rainfall on basin.					Drainage area. (*a*)	Flow per second, average for the 24 hours. (*b*)	Theoretical horse-power.		Effective horse-power utilized.
	Spring.	Summer.	Autumn.	Winter.	Year.			1 *foot fall.*	20 *feet fall.*	
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Sq. miles.*	*Cubic feet.*			
Low water, dry year	11½	12	12	10	45½	207	90	10.22	200	125
Low water, average year							120	13.63	270	
Available 10 months, average year							140	15.90	320	

a Including that of Jabish brook. *b* In low water the flow and power can be doubled for 12 hours.

At Bondsville, a little way farther up stream, the Boston Duck Company owns two falls, both improved. At the time this place was visited the lower dam and canal had been built, and the company designed to erect soon a mill in connection for the manufacture of some kind of cotton goods. The available fall on this privilege is 21.2 feet, and leaves nothing of importance down to Barrett's Junction, a half-mile below.

The two dams at Bondsville are in style of construction almost exactly alike, varying slightly in dimensions. The lower was built in 1879, and cost $14,000. It is of stone in cement, cut bed and build, and is of uniform construction from face to back, with roll-way 145 feet long. The base is 16 feet, the height 12 feet from top of apron-stone to top of coping, and the face has a batter of an inch and a half to the foot. The coping-stones project 12 inches from the face of the dam, are 12 inches thick, 9 feet long, and slope back at the rate of perhaps 1 in 4. The face of the dam rests directly on apron-stones, which project 2 feet under it and 11 feet in front. The back of the dam rests upon a priming-wall 2 feet thick and 6 feet deep, and the down-stream end of the apron rests upon a similar wall 4 feet deep. The space between these two walls is filled in with grouted gravel. The natural bed of the stream here is entirely gravel.

The upper dam is 15 feet high, 18 feet wide at the base, with roll-way 130 feet long, and cost $20,000. A canal about 1,000 feet long leads to the mill, where about 500 horse-power is used under 21 feet fall. The Boston Duck Company manufactures light cotton-duck, runs 18,000 spindles and 324 looms, and employs 400 hands. A 160 horse-power engine is used for auxiliary power in low water, and during the summer of 1882 was run for 30 days. The upper dam sets the river back some 3 miles and gives a large storage, so that in a very dry season the night-flow of the stream is ponded for a period of two or three weeks.

Above Bondsville there is said to be no opportunity for a privilege before reaching West Ware. At that point there is a log dam, from 150 to 200 feet long, with a fall of 8 feet. Three-quarters of this privilege is said to be owned by J. B. Warren, of Springfield, and one-quarter by the proprietor of a small cotton-batting mill on the right bank. It is claimed that by extending the present canal 200 rods, or, much better, by building a new dam that distance down stream, a fall of 16 feet can be realized, and a good flowage.

Estimate of power at West Ware.

Stage of river.	Drainage area.	Flow per second, average for the 24 hours. (*a*)	Theoretical horse-power.			Effective horse-power utilized.
			1 *foot fall.*	8 *feet fall.*	16 *feet fall.*	
	Sq. miles.	*Cubic feet.*				
Low water, dry year	183	70	7.95	65	130	35
Low water, average year		100	11.36	90	180	
Available 10 months, average year		120	13.63	110	220	

a In low stages the flow and power can be doubled, during the ordinary working-hours, by pondage here and above.

The next dam is at Enfield, on the Middle branch, some 12 miles from Three Rivers. At the lower village the Minot Company uses 11 feet fall and 72 horse-power in the manufacture of woolen goods.

At the upper village the Swift River Company runs 8 sets of cards on fancy cassimeres. This company has 16 feet fall, and uses one wheel of 70 or 80 horse-power for the main mill, besides from 30 to 35 horse-power for a small saw-mill, grist-mill, and box-shop. There is a moderate pondage here, but a mile up stream the company has a low dam, consisting of a sill about even with the natural water-surface, surmounted by 15 or 18 inches of flash-boards; and as the river is very flat above, it is set back a long distance on both the Middle and East branches. The pond thus formed is used for storing the night-flow, which it does, without allowing wastage over the dam, for from three to six weeks in an average year.

The stream above Enfield was not visited. There are said to be occasional small mills in that portion, but none of special importance.

MILL RIVER.

This important little stream joins the Connecticut river from the west in the town of Northampton, Massachusetts. It is 16 miles long, and contains within its drainage basin 58 square miles. The section thus included is hilly, and toward the headwaters becomes quite elevated, with many steep and rocky slopes.

The stream is sustained in low water by two reservoirs, distant about 9 miles from the village of Leeds. They lie near the center of the town of Goshen, and about half a mile apart on the course of a small stream. The upper reservoir is the smaller, flows 64 acres, and can be drawn down about 15 feet from full-water line, though the average depth is much less. It lies close to the limits of the water-shed, and has, in fact, a dam at each end, the farther one to prevent flow over toward Cummington. It is fed partly by springs and one or two little brooks, but mainly by spring rains and melting snows, and fills readily. The lower reservoir flows 133 acres, and can be drawn down 25 feet at the gates. It receives no stream except the one coming from the upper reservoir, but fills regularly.

These reservoirs were built before the one which failed in 1874. They are owned by the Hampshire Reservoir Company, an association made up of ten or eleven of the mill-owners, who hold stock about in the proportion of their fall. Once in two years or so they are assessed for repairs. The reservoirs are usually drawn upon from the latter part of June till the middle of September, and the flow of the stream is kept up as nearly as possible to the wants of all but two or three of the largest mills. But even with the help of the reservoirs the supply of water is insufficient, and nearly all the mills have auxiliary steam-power. The present reservoirs could not be raised farther, but the Williamsburg reservoir, which failed, might be rebuilt, and would in that case be of great assistance to the stream. Its location was naturally fine, and many of the mill-owners are in favor of rebuilding it.

The breaking away of this reservoir, May 16, 1874, was a memorable disaster, and it may be well to give a few facts regarding the construction of the dam and the causes of its failure. Soon after the occurrence an examination was made by a committee of the American Society of Civil Engineers, and from their report (*a*) the information here given is almost entirely drawn. They described the dam as having been—

* * * between 500 and 600 feet long, and about 43 feet high at the highest point near the center, diminishing to nothing at the ends, forming a reservoir when filled, in the valley above it, of an area of 111 acres, with an average depth of about 20 feet. At the time of the failure, the water was about 4 feet below the top of the embankment (not an unusual height at this season), and within a few months it has been at least a foot higher. The failure took place between 7 and 8 o'clock on the morning of May 16, last, when probably three-quarters of the contents of the reservoir escaped in about 20 minutes, or at the rate of about 60,000 cubic feet a second, destroying in its course through the steep and narrow valley below, 143 lives, and property to the amount of more than $1,000,000. The dam consists of an earthen embankment with a longitudinal wall of stone and cement through its center, a waste-way 33 feet wide in the natural ground at one end of the embankment, and a 16-inch pipe through the embankment and wall at the lowest point, for the discharge of the water as wanted for use at the mills below.

The dam was built in 1865 by the reservoir company, and therefore stood for eight or nine years before giving way. It was built upon a foundation consisting naturally of very compact hard-pan, overlaid by about 2 feet of coarse gravel and a few inches of soil. The embankment was formed of a washed and porous gravel obtained from a neighboring side-hill; it contained a little loam, but had nothing binding in its character, and was not suited to making into a puddle which should be impervious to water. The chief reliance had to be placed, for retaining the water, "* * * in the cement wall and the complete union of its base with the hard-pan; the main office of the embankment being to support and protect the wall." But the evidence showed that no efficient measures were taken to insure this complete union and thus to guard against percolation. The stored water was free from sediment, which, if present, might have been deposited so as to render the embankment water-tight. The embankment slopes were only 1½ to 1, and its top was carried only 2 feet above the top of the wall, too slight a covering to guard against frost in this cold climate.

A great fault, moreover, seems to have existed in the inspection of the work, which was not skillful and was much of the time altogether lacking. The bottom of the wall was not even in all cases carried down to hard-pan; it was laid up dry and grouted 5 feet at a time; the mortar was poor and did not fill all the crevices. The soil and

(*a*) *Transactions of the American Society of Civil Engineers*, Vol. III, paper No. xc.

porous gravel were only partially removed from the site of the dam. It is not surprising, therefore, in view of the various defects pointed out by the committee, and which have been briefly mentioned above, that when the trying time came the whole structure quickly collapsed. In speaking of the failure the committee said:

It is probably not possible to ascertain with certainty the immediate cause of the failure, but from the evidence obtained we can come to no other conclusion than that the water found its way under the wall at a point about 100 feet from the discharge-pipe, causing a slip in the embankment on the down-stream side of the center wall, which, being then unsupported, yielded to the pressure on the upper side, and, falling over, made a breach, which was rapidly enlarged by the wasting away of the embankment and the fall of other parts of the wall. It may be asked, if this was the immediate cause, why did it not happen before, when the reservoir was at a higher level? The answer, we think, would be that there has been a gradual working out of the gravel under and near the wall, and loose places or cavities formed, which, when they had attained a certain development, would suddenly lead to the failure.

The bed of the stream is largely composed of coarse granite and gneiss, and affords secure foundation for the dams, which are in most cases built of stone. Much the greater part of the fall of the stream, in the main portion of its course, is taken up and in use; but there yet remains some unimproved fall, probably much the best privilege being one at Leeds, with 35 feet available fall, owned by Mr. George P. Warner, of the Mill River Button Company. Mr. Warner holds it for sale, and has 30 or 40 acres of land adjoining. The privilege was formerly improved by a dam, part of which still stands in ruins; there is a rock ledge in each bank at its site. With 35 feet fall probably 140 horse-power could be realized, 12 hours in the day, during at least nine months in an average year.

There are some concerns, of moderate size, above Williamsburg, but the most important are from that point to the mouth, and are mentioned in the following list:

Principal water-privileges on Mill river from Williamsburg to the mouth.

Locality.	Firm.	Manufacture.	Fall.	Remarks.
			Feet.	
Williamsburg	H. L. James	Woolen goods	16	
Haydenville	Hayden Company	Brass goods	18	65 horse-power used in 1880.
Do	Lucius Briggs, Son, & Co	*Cotton goods*	22	*85 horse-power used in 1880.*
Leeds	Nonotuck Silk Company	Sewing-silk, machine-twist, and knitting-silk.	30±	2 privileges.
Do	Mill River Button Company	Vegetable-ivory buttons	12	50 horse-power in use in 1880.
Do	Owned by G. P. Warner	Unimproved	35	For sale. Good power.
Florence	Greenville Manufacturing Company	Shootings and drills	}	5,000 spindles.
Do	Nonotuck Silk Company	Sewing-silk, machine-twist, and knitting-silk.	} 24	
Bay State village	Northampton Cutlery Company	Cutlery	22	
Do	Clement Manufacturing Company	....do	10	
Paper-mill village	Vernon Paper Company			
Northampton	C. A. Maynard	Hoes	14	120 horse-power used by Maynard in 1880, and 30 horse-power by concern for making tape.
Do	H. Lamb & Co	Wire works	10	Power used from same privilege by grist-mill.

THE DEERFIELD RIVER.

In point of area drained, the Deerfield river ranks second among the tributaries of the Connecticut river, containing within its basin 646 square miles. It rises in the town of Stratton, in southern Vermont, and runs thence southerly into Franklin county, Massachusetts; 4½ miles south of the Vermont line it turns, through fully ninety degrees, and pursues a somewhat southeasterly course, joining the Connecticut river a mile or so southeast of Greenfield.

The stream affords opportunity for developing a number of good privileges. It has a rapid fall, and at most seasons carries a considerable volume of water. It is not, however, assisted by storage reservoirs, and there are very few mill-ponds even, except in the upper waters. So far as could be learned there is not in Massachusetts a single natural pond of importance tributary to it; in Vermont there are shown on the maps half a dozen ponds of moderate size in the upper basin, but no information can here be given as to their true extent or value. The country drained by the Deerfield is hilly throughout, and even rises to mountains in the upper basin, where the slopes are very abrupt and rocky. Naturally, therefore, the stream runs very low in the dry season, and is subject, on the other hand, to sudden and extreme rises. After the storm of September 21–23, 1882, which was an unusually heavy one, drift was noticed that had been left 10 feet above low water on the bank near Charlemont, where the stream was of normal width and had a moderate current. On the Shelburne Falls dam, about 500 (?) feet long, the depth of water in that storm was estimated at about 6 feet, which has frequently been observed before.

The Fitchburg railroad follows the river closely from its mouth to Hoosac Tunnel, at which point the upper course of the river diverges. The New Haven and Northampton railroad also follows the lower river for a short distance, and then continues on to North Adams over the Fitchburg tracks. Although the stream is thus skirted

in the main part of its course by railroads, there are, with the exception of Shelburne Falls, no villages or local industries of much importance upon its banks; the adjoining country does not appear rich agriculturally, and settlement is rather sparse.

In a distance of over 40 miles from its mouth there are but three improved water-privileges on the Deerfield river—at Shelburne Falls, Hoosac Tunnel, and Readsborough. It is not easy to account entirely for the slight development of power on this stream, which seems as favorably situated as other streams that are much more used. It is not improbable, however, that the present rather fluctuating, wild, and unrestrained character of the river may have much to do in deterring manufacturers from improving it, so long as they can find other streams that are free from this disadvantage. The Deerfield is undoubtedly a violent river in freshets, and is visited by heavy runs of ice, but these are faults common to a great many New England streams in their natural state; they call for strongly-constructed works, but become much modified as the streams are built up with dams, and as storage reservoirs are developed to distribute through the dry season the melting snows and heavy rains of spring. Again, portions of the valley are undoubtedly too confined to accommodate villages of importance, or even mills; but there are numerous widenings where there is abundant room. As regards shipping facilities, it has already been mentioned that two lines of railroad reach the stream, and these give easy communication with three important points; the main portion of the course is distant, by the Fitchburg railroad, from 110 to 140 miles from Boston, and from 50 to 80 miles from navigation on the Hudson river at Troy, and by the New Haven and Northampton railroad the distance to New York is about 175 miles.

Table showing the fall in the Deerfield river.

[Authority for elevations: Profile of Troy and Greenfield railroad.]

Locality.	Distance above mouth.	Elevation of water-surface above sea-level.	Fall between points.	Distance between points.	Fall per mile between points.	Remarks.
	Miles.	*Feet.*	*Feet.*	*Miles.*	*Feet.*	
Readsborough, Vermont	*a* 42.5	1,154				
			400	10	40.0	Elevation approximate. Fall said to be about 400 feet from Readsborough to Hoosac Tunnel dam.
Top of Hoosac Tunnel dam	32.5	754				
			186	5	37.2	
At Zoar bridge, 24½ miles west of Greenfield	27.5	568				
			396	18	22.0	
At Bardwell's bridge, 8½ miles west of Greenfield	9.5	172				
			46	5	9.2	
At Deerfield meadows, opposite old Deerfield	4.5(?)	126				

a Mouth of West branch.

For the lower 6 miles of its course the Deerfield runs through fertile meadows bordered on the east by high hills. The meadows are largely devoted to grass, but are also well cultivated in corn. The river here runs smoothly, and its bed appears to be sand and fine gravel. Immediately above the sharp turn in the vicinity of Wapping the hills close in on either side, and the river runs about 300 feet wide over a bed of coarse gravel and between high steep banks of gravel or rock. It now lies for some distance at the bottom of a deep and narrow valley too difficult of access to invite improvement; the carriage-road leaves the stream, and does not again approach it till near Shelburne Falls, but the railroads follow either bank high above the river, until they connect at Bardwell's. In the vicinity of Shelburne Falls the valley widens out, but continues flanked by high hills, their steep slopes covered with brush and young timber. The river here flows over a bed of gravel and bowlders, with ledge rock appearing at intervals in the bed and frequently in the banks.

About half a mile, by straight course, below Shelburne Falls, J. W. Gardner, esq., of that place, owns a water-privilege with the adjoining land. He would like to retain some interest in the privilege, but would offer liberal inducements to parties wishing to improve it. The stream here runs southerly and has a very rapid descent. The right bank shows a long and extensive exposure of granite rising 15 or 20 feet from the water. The left bank shows similar ledges, but they do not occur at the same time in both banks. Elsewhere the banks appear generally firm, with bowlders cropping out, but at one or two points the left bank is sandy. That bank is also steep and unsuited to building, while the right bank is succeeded by gently-sloping ground, of suitable character and sufficient extent for mills and a village. Just beyond this easy slope, and farther up the hillside, is the railroad. It was stated that the Fitchburg Railroad Company had offered to run a spur-track down to the grounds at its own expense if the power should be improved. It is a question as to how the privilege could best be developed. A ledge of rocks running across the stream offers a natural foundation for a dam, but the left bank is there sandy. If a canal of any considerable length were run, it is probable that rock would be encountered and blasting be necessary. Somewhat farther down stream the right bank is high and appears firm, while on the opposite side is a high granite ledge. The right bank rises about 25 feet from the water and is succeeded by fine level ground. Probably a dam 15 feet high could be built here, and the fall used at once without a canal. Mr. Gardner claims an available fall of 18 feet for his privilege, the power of which may be estimated as follows:

Estimate of power near Shelburne Falls.

Stage of river.	RAINFALL ON BASIN.					Drainage area (approximate).	Flow per second, average for the 24 hours. (a)	Theoretical horse-power.		
	Spring.	Summer.	Autumn.	Winter.	Year.					
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Sq. miles.*	*Cubic feet.*	1 *foot fall.*	15 *feet fall.*	18 *feet fall.*
Low water, dry year	11	13	12½	9½	46	475	140	15.90	240	290
Low water, average year							190	21.58	320	390
Available 10 months, average year							290	32.94	490	590

a It is to be noticed that both here and above the village of Shelburne Falls the descent of the stream is so rapid that very little storage is to be obtained, and it is not therefore practicable to increase much, during the 10 or 12 working hours, the average flow for the 24 hours.

At the village of Shelburne Falls the water-power is owned almost entirely by the Lamson & Goodnow Manufacturing Company, employing 300 hands in the manufacture of cutlery. The dam runs across the river in an irregular line, convex up stream, and is built upon huge ledges of granite rock which are exposed largely at this point. It is built of logs, is perhaps 9 feet high, and cost approximately $7,000. The pondage is insignificant, extending back but a few hundred feet at the farthest. At the south end of the dam is a very heavy bulkhead of rubble and cement masonry, 18 or 20 feet wide on top, rising 10 feet above the ordinary water-surface and running inshore some distance to high ground. A short race leads to the mills, where power is taken from two overshot wheels, each of 125 horse-power, and a 100 horse-power turbine. These run under a head of 25 feet.

On the north side of the river are several small concerns. Frost & Bartlett rent power for a saw-, planing-, and 2-run grist-mill, but are shut down in low water. Just below there is a small tannery occasionally using a few horse-power; and, lastly, H. H. Mayhue has a small shop for making bits and gimlets, where he uses about 8 feet fall and, as stated, 25 horse-power. Mayhue claims a right to one-eighth the flow of the river, but in practice shuts down in low water for the benefit of the Lamson & Goodnow company. Throughout an average year this company can run its works at full capacity by water-power without hinderance, but in a very dry season, such as the summer of 1882, there is a little shortage for about two weeks, but both overshots can always be run.

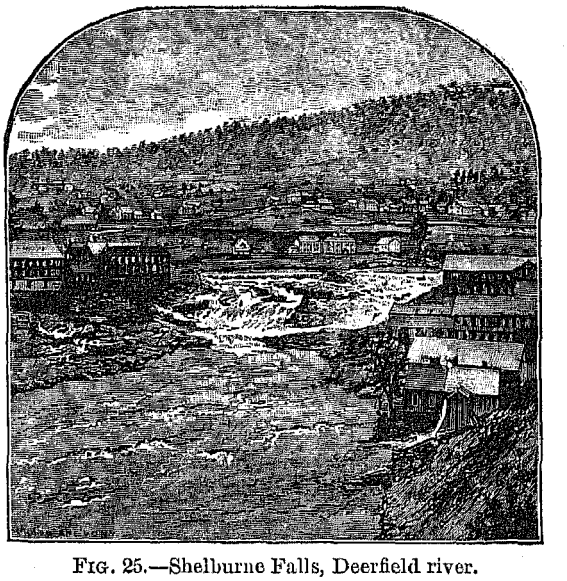

FIG. 25.—Shelburne Falls, Deerfield river.

The dam was originally shorter than at present, and the bulkhead was subject to injury from high freshets and from floating ice, which, owing to a bend in the stream, naturally sets that way. In October, 1869, the water is estimated to have run 12 or 14 feet deep on the old roll-way, and the bulkhead and four of the buildings belonging to the Lamson & Goodnow works were carried away. The roll-way was subsequently extended 175 feet to its present length of perhaps 500 feet, and a strong bulkhead was built which seems capable of withstanding any force of the river. On the dam, as at present, the depth of water in an ordinary spring freshet does not exceed 3 feet.

There is a very rapid descent in the river below the dam, and from the top of that structure down to the foot of the principal rapids there is a fall of 70 feet, all owned by the Lamson & Goodnow company. There is thus a large amount of fall and power not in use, and this the company is willing to sell. Its present canal would not probably carry much surplus water beyond its own needs, but by extending the tail-race as a second level the water could be used over again, and there is a fair location for a mill.

Estimate of power on the Lamson & Goodnow Manufacturing Company's privilege.

Stage of river.	Drainage area.	Flow per second, average for the 24 hours.	Theoretical horse-power.				Effective horse-power utilized.
	Sq. miles.	*Cubic feet.*	1 *foot fall.*	25 *feet fall.*	35 *feet fall.*	70 *feet fall.*	
Low water, dry year	474	140	15.90	400	560	1,110	400–450
Low water, average year		190	21.58	540	760	1,510	
Available 10 months, average year		290	32.94	820	1,150	2,310	

From Shelburne Falls up to Hoosac Tunnel there is a pretty continuous shoal, with only occasional short stretches of quiet water. The bed and banks are gravelly, and the former seldom shows any considerable rock exposure. At Scott's bridge, however, a mile or so from Shelburne Falls, there is a rapid fall over rock; the stream is there narrow, confined between high banks, and the site for building is not very favorable. Between Shelburne Falls and Charlemont the valley is generally of fair width, and especially at East Charlemont and

vicinity it opens out finely, the hills receding from the river and leaving a splendid site for a village. Again, at Charlemont, at a point between there and Zoar, and at Hoosac Tunnel station, the valley widens out, and the stream is bordered by flat or gently-rising ground, ample for building-purposes. Elsewhere than at the localities mentioned the valley is generally narrow and inclosed by steep slopes.

Opposite Hoosac Tunnel station the river is about 150 feet wide. Just as the railroad strikes in toward the mountain the river bends sharply and comes from the north, and its valley soon becomes contracted and narrow as we ascend. The old state dam is perhaps 2,000 feet above the tunnel, at a point where the hills rise quite abruptly from the stream. At the west end the dam abuts on a huge ledge of outcropping rock, the strata of which are tilted almost vertical. At the opposite end the bank is gravel, and the abutment is of masonry, into which are built vertical ribs of timber, with plank-facing over all. The masonry is in very good condition, but the ribs are decayed and much of the planking is gone. The dam is a straight structure, the roll-way stated to be about 250 feet long and about 20 feet high above the river-bed; it is built of logs dressed and notched, and has a nearly vertical face, and an apron in three broad offsets of 30 or 40 feet each. Both the dam and apron are in fine condition. The bulkhead is of timber, built from one solid ledge to another, between which the canal was blasted out for a short distance.

The canal has a length of about a third of a mile, is from 25 to 30 feet wide and 8 feet deep. About midway of its length there is between it and the river a fine level piece of ground, perhaps 200 feet wide, and well suited to use for a mill-site. At the foot of the canal is a machine-shop of the Fitchburg railroad, with a small saw-mill adjoining. The water-wheels have a capacity of 225 horse-power, but only a small amount of this is actually in use. The head on the wheels is 29½ feet. The hydraulic works which have been described were originally built by the state of Massachusetts during the construction of the Hoosac tunnel, and the power was used for compressing air; 500 or 600 horse-power was in constant use, day and night, for that purpose. The superintendent of the machine-shop states that during the progress of the work referred to it was the experience that for two months in summer there was commonly only about enough water for 200 horse-power, but for most of the year abundance for the full capacity of all the wheels. The dam sets back the river about three-quarters of a mile, but when the power was in use for the compressors it was employed continuously and the pondage exerted no especial influence.

The privilege is said to be still owned by the state. The improvements are very substantial and render the power a valuable one. The ordinary spring-freshet rise on the dam is stated to be about 5 feet. There is usually a heavy run of ice in spring, and temporary gorges occur in the river below Hoosac Tunnel. Owing to a bend in the river above the dam, ice also piles up there, sometimes to a thickness of 25 or 30 feet.

Estimate of power at Hoosac Tunnel.

Stage of river.	Rainfall on basin.					Drainage area.	Flow per second, average for the 24 hours.	Theoretical horse-power.		Effective horse-power of wheels now in place.
	Spring.	Summer.	Autumn.	Winter.	Year.			1 foot fall.	29½ feet fall.	
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Sq. miles.*	*Cubic feet.*			
Low water, dry year	11	13	12½	9½	46	234	50	5.68	170	225 (Only partially used.)
Low water, average year							80	9.09	270	
Available 10 months, average year							130	14.77	440	

No knowledge was gained of any power being used on the Deerfield for 10 miles above Hoosac Tunnel, or until reaching Readsborough, Vermont. At that point the Deerfield River Company has recently made extensive improvements for the purpose of obtaining power for grinding wood pulp. A dam 40 feet high and 160 feet long at the crest has been built; it rests on rock, is 80 feet wide at the base, and is built up as a log crib-work, filled in with loose stone and covered with 6-inch planking. The back has a long slope; the face is vertical, or nearly so, except a short slope from the crest and an offset part-way down the front for breaking the force of overfalling water. The water is to be used in two falls, of 37 and 40 feet, respectively.

Estimated volume and theoretical power per foot fall at various points on the Deerfield river.

Locality.	Rainfall.					Drainage area.	Flow per second, average for the 24 hours.			Theoretical horse-power per foot fall.		
	Spring.	Summer.	Autumn.	Winter.	Year.		Low water, dry year.	Low water, average year.	Available 10 months, average year.	Low water, dry year.	Low water, average year.	Available 10 months, average year.
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Sq. miles.*	*Cubic feet.*	*Cubic feet.*	*Cubic feet.*			
Hoosac Tunnel	11	13	12½	9½	46	234	50	80	130	5.68	9.09	14.77
Charlemont, below Mill brook	11	13	12½	9½	46	338	80	120	190	9.09	13.63	21.58
East Charlemont	11	13	12	10	46	356	90	130	210	10.22	14.77	23.86
Shelburne Falls	11	13	12	10	46	474	140	190	290	15.90	21.58	32.94
Mill Village, 6½ miles from the mouth	11	13	12	10	46	536	160	220	330	18.18	24.99	37.49

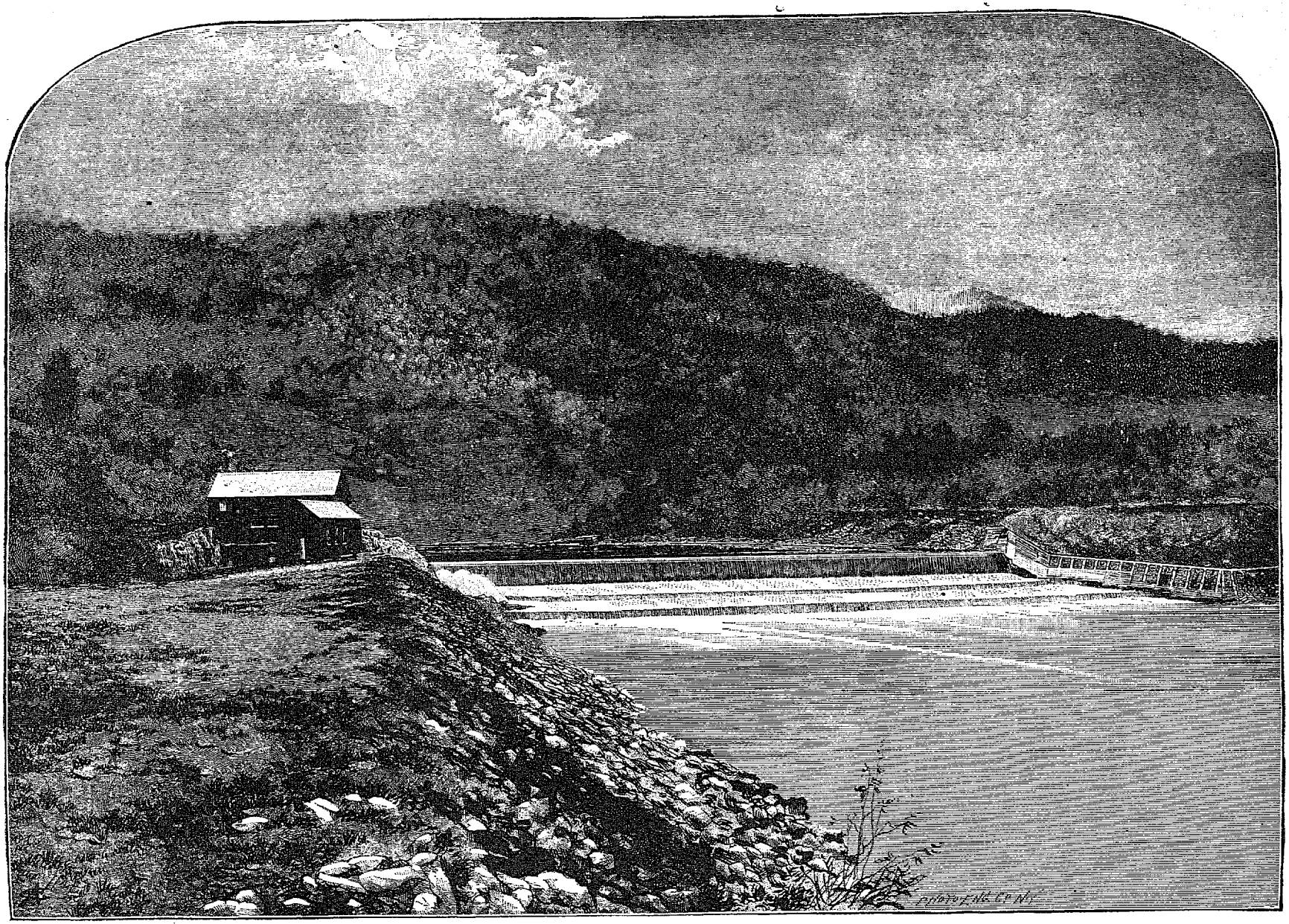

FIG. 26.—Hoosac Tunnel Dam, Deerfield river.

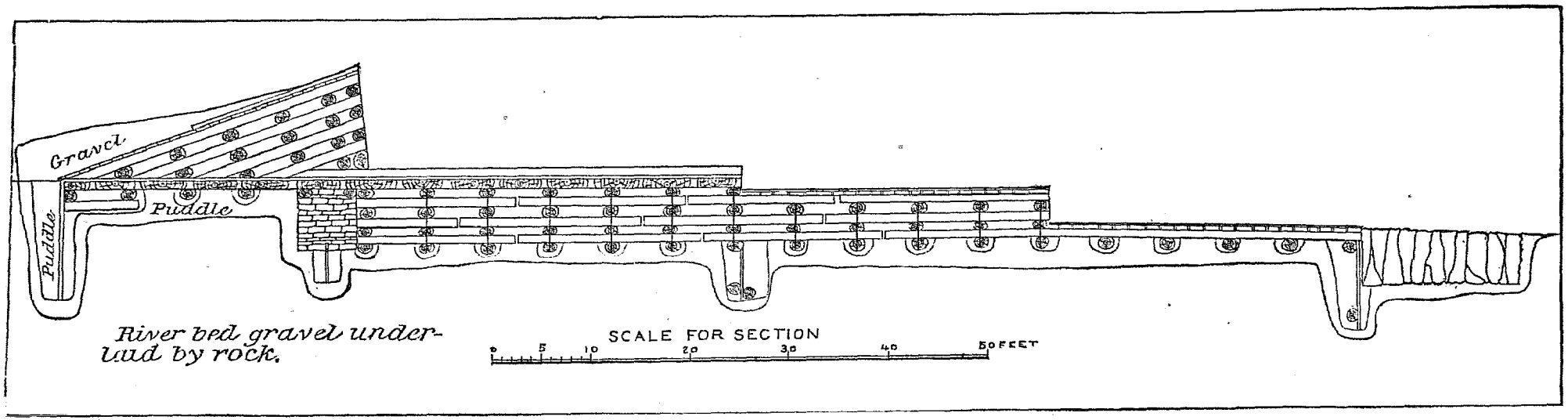

FIG. 27.—Cross-section of Hoosac Tunnel Dam.

MILLER'S RIVER.

The main stream may be regarded as formed in the town of Winchendon, in northern Worcester county, Massachusetts, by the union of branches from the town of Ashburnham and from lake Monomonac, the latter on the New Hampshire boundary. The river then pursues an irregular westerly course for about 32 miles, passing into Franklin county adjoining the Connecticut a little way above Turner's Falls. In its upper course it receives Otter river from the south and Tully river from the north, and those are its principal tributaries, although it is joined by numerous other minor streams. Its drainage area comprises 396 square miles, a small portion of which lies in New Hampshire. Although not a very large stream, Miller's river is a valuable one for milling purposes on account of its uniform and well-sustained volume. It is quite in contrast to the Deerfield river in this respect, as well as in the character of its valley, which is much more open, in general, and better suited to settlement. The fall is also large, amounting in round numbers to 600 feet from Royalston to the mouth, a distance of 23 or 24 miles.

Table showing the fall in Miller's river.

[Authority for elevations: Fitchburg railroad profile.]

Locality.	Distance from mouth. (a)	Elevation of water-surface above mean sea-level. (b)	Fall between points.	Distance between points.	Fall per mile between points.	Remarks.
	Miles.	*Feet.*	*Feet.*	*Miles.*	*Feet.*	
First bridge west of South Royalston	23.1	768				
			93	2.0	46.5	
Second bridge west of South Royalston	21.1	675				
			184	9.6	19.2	
First bridge west of Orange	11.5	491				
			56	4.9	11.4	
Bridge between Erving and Miller's Falls	6.6	435				
			202	4.9	41.2	
Water above Miller's Falls dam	1.7	233				
			59	1.7	34.7	
Mouth of river	0.0	174				Estimated from elevation at Turner's Falls.

a Approximate.

b These elevations, as given by the Fitchburg railroad were referred to mean high water in Boston harbor, which is here assumed to be 5 feet above mean sea-level.

The area drained by Miller's river contains many ponds and lakes, the larger of which, with their approximate areas, are mentioned in the following list. There are said to be two or three storage reservoirs which are drawn upon to supply the stream in the dry season, but nothing definite could be learned regarding them. In particular, a large one is mentioned in the town of Winchendon, which is probably lake Monomonac.

List of the larger ponds and lakes tributary to Miller's river.

Locality (town).	Name of pond.	Approximate area.	Drains to what stream.	Authority.
Massachusetts.		*Acres.*		
Warwick	Pond east of Long pond	118	Moss brook	H. F. Walling. (a)
New Salem	Reservoir in northeast corner	320	Miller's river	Do.
Winchendon, Massachusetts, and Rindge, New Hampshire.	Monomonac lake	800	do	Map of New Hampshire. (b)
Winchendon	Pond on Ashburnham line	100	do	H. F. Walling. (a)
Do	Reservoir in south part	122	Otter river	Do.
Gardner	Crystal lake	216	do	Do.
Ashburnham	Lower Naukeag pond	150	Miller's river	Do.
Do	Upper Naukeag pond	302	do	Do.
Athol	White pond	100	do	Do.
Phillipston	Reservoir on Athol line	130	do	Do.
Petersham	do	136	do	Do.
New Hampshire.				
Rindge	Reservoir above lake Monomonac	100	do	Map of New Hampshire. (b)
Do	Pearley pond	200	do	Do.
Fitzwilliam	Sip pond	120	do	Do.
Do	South pond	180	Tully river	Do.
Do	Meadow pond	120	do	Do.
	Total of 16 ponds	3,214		

a See Appendix B, *Report of the Massachusetts State Board of Health*, 1878.

b Measured by planimeter.

The first water-privilege on Miller's river is close to the mouth, where Mr. James H. Brown, who resides near at hand, claims an available fall of 35 feet. Almost directly at the mouth there were once a saw- and a grist-mill, and part of the old log-dam is still standing. The bed and banks are there rocky and the stream has quite a pitch. A quarter of a mile above, the river is wider and its bed is crossed by a low ledge. Mr. Brown states that a dam 15 feet high at that point would flow an extensive swamp bordering the stream a little way above, and would give a fine storage. A canal could be carried from this site down the left bank to the mouth; any mill using the entire fall of the privilege would be located at the latter point and would discharge directly into the Connecticut river. This would, however, render it liable to occasional loss of head by high water in that river, the ordinary spring rise amounting to 10 or 15 feet. The land about the mouth is hilly and not especially favorable to the location of large mills; still there is a fair site for building on a point of land formed by the two rivers, and not owned by Mr. Brown. There is no village at this locality, though the privilege is conveniently situated at a distance of only half a mile from the New London Northern railroad, and about 4 miles by road from Turner's Falls; a road bridge crosses the river just above its mouth.

The power to be obtained on this privilege is an important one, and would have the benefit of the entire drainage area of the river. It does not seem, however, as though so large a fall as 35 feet is available. Judging by the elevations of the Fitchburg railroad the fall from the top of the Miller's Falls dam to the mouth of the river does not exceed 60 feet. Of this, 32 feet is included in the privilege at Miller's Falls, leaving say from 25 to 28 feet thence to the mouth unimproved. No gaugings of this river have been reported, but the power at Brown's privilege may be estimated as follows:

Estimate of power at the mouth of Miller's river.

Stage of river.	Rainfall on basin.					Drainage area.	Flow per second, average for the 24 hours. (a)	Theoretical horse-power.			
	Spring.	Summer.	Autumn.	Winter.	Year.			1 foot fall.	15 feet fall.	25 ft. fall. (b)	35 ft. fall. (b)
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Sq. miles.*	*Cubic feet.*				
Low water, dry year	12	12	11½	10½	46	396	220	24.99	370	620	870
Low water, average year							260	29.54	440	740	1,030
Available 10 months, average year							300	34.08	510	850	1,190

a The flow and power as given could be materially increased during the ordinary working hours by the pondage here and above.
b See preceding remarks.

At Miller's Falls the river makes a decided bend and incloses a tract of quite level land. On the upper side of the bend the Miller's Falls Company has a dam about 175 feet long. It was built as a framed structure, but some thirteen years ago half of it was carried away and was afterward replaced by log-work; it has a sloping face and apron, planked over. A race some 700 feet long leads to the works of the Miller's Falls Company, manufacturer of general hardware, and especially of bits, braces, and vises. The main building measures 250 by 50 feet, and employment is given to 150 men. Two water-wheels, having a combined rated capacity of about 200 horse-power, are run under 16 feet head. The tail-water, instead of passing directly into the river, runs about 600 feet across the bend, and is again used by, first, the Lester & Lyman Manufacturing Company, hardware, using 16 feet fall and a 30 horse-power wheel; and, secondly, from the same level, by W. J. Phelps for a small grist-, saw-, and planing-mill and wheelwright shop. The Miller's Falls Company usually has sufficient water throughout the year, although in a low stage there is very little surplus. During the dry summer of 1882 the supply did not run short except on Monday mornings, and the scarcity then was due to the filling up, over Sunday, of the ponds along the river above. The pondage above the Miller's Falls dam is unimportant. The river is about 175 feet wide in this vicinity, and is considered to be very uniform in flow. The freshet depth on the dam is estimated not to exceed 3 feet.

About 100 rods above its dam the Miller's Falls Company owns an unimproved fall of 15 feet. A road bridge spans the river there, and just below on the west bank there is a good mill-site. Immediately succeeding this privilege, up stream, the same company owns an unimproved fall of 30 feet. Both these privileges are held for sale.

There is no dam on the river between Miller's Falls and Erving, although from the Fitchburg Railroad crossing below the latter point down to slack-water from the Miller's Falls dam there is a descent of 202 feet. As soon as we ascend above the village of Miller's Falls the river valley becomes narrow and is shut in by high hills which rise with abrupt slopes from the stream. This character is essentially retained till within perhaps 2 miles of Erving; there is then a fine site on the right bank, a wide meadow rising gently from the river. All the way between Miller's Falls and Erving the rapid fall of the river is easily seen as it comes rushing down impetuously over a gravelly bed. Although in this distance the valley is generally too narrow to accommodate with convenience extensive buildings or a village, still occasional points can probably be found where mills of moderate size might be located to advantage.

Estimate of unimproved power between Miller's Falls and Erving.

Stage of river.	RAINFALL ON BASIN.					Drainage area.	Flow per second, average for the 24 hours. (a)	Theoretical horse-power.			
	Spring.	Summer.	Autumn.	Winter.	Year.						
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Sq. miles.*	*Cubic feet.*	1 *foot fall*	15 *feet fall.*	30 *feet fall.*	200 *feet fall.*
Low water, dry year	12	12	11½	10½	46	376-393	220	24.99	370	750	5,000
Low water, average year							250	28.40	430	850	5,680
Available 10 months, average year							290	32.94	490	990	6,590

a Mean for the section of river considered.

At Erving there is an old crib-work dam filled in with stone; it is built in two sections, making nearly a right angle up stream, and has a sloping face. A wooden bulkhead admits water to the race, which is several hundred feet long. The fall at the mills varies from 9 to 12 feet, according to position on the race. The power is used as follows: (1) E. H. Spring owns one-quarter of the privilege, and uses 9 feet fall and not to exceed 25 horse-power for a small grist-mill and in the manufacture of pail-staves. (2) The Washburn & Heywood Chair Company owns half the privilege, and uses 10 or 12 feet fall and 200 horse-power rated capacity of wheels in the manufacture of cane- and wood-seat chairs, sashes and doors, and wooden pails. Its production is about 600 chairs and 300 pails per day. (3) Noah Rankine owns one-quarter of the privilege, using 12 feet fall and, as he estimates, 50 horse-power in making wood-seat chairs. The Washburn & Heywood company, the largest user of power here, is commonly able to run its works at full capacity throughout the year.

From this point up to Athol, which is as far as the river was examined, the utilized powers succeed one another so closely as not to leave intermediate fall of sufficient amount to constitute a separate privilege. The surrounding country, which has hitherto been very hilly, now subsides and becomes level. The stream likewise grows flat, and is bordered by wide meadows, through which it flows between low banks. This character is most marked in the vicinity of Orange, and continues until beyond Athol, when hills of moderate height are again met and the fall becomes more rapid.

The first power above Erving is improved by a dry-stone dam capped with wood, a short race leading thence to the mill. The fall in use is 10 feet, but the proprietor claims that the dam can be raised 5 feet and a largely increased storage obtained at the same time. Power is used by J. Stone & Sons, manufacturers of piano-cases, of which they turn out $50,000 worth annually; and by J. Stone for a saw-mill. The site is a good one, with the railroad just across the river and a road bridge between. The horse-power in use was not ascertained, but it was stated to be but a small portion of the amount available with a tight dam. The surplus power is held for rent or sale. Chestnut, pine, and hard wood are the principal varieties of timber in this section, and the supply still holds good, though not of first quality.

Estimate of power at Stone's privilege (between Erving and Wendell Depot).

Stage of river.	Drainage area.	Flow per second, average for the 24 hours.	Theoretical horse-power.			Effective horse-power utilized.
	Sq. miles.	*Cubic feet.*	1 *foot fall.*	10 *feet fall.*	15 *feet fall.*	
Low water, dry year	368	210	23.86	240	360	*a* 115 (?)
Low water, average year		240	27.26	270	410	
Available 10 months, average year		270	30.67	310	460	

a Power in 1880, by census enumerators' returns.

NOTE.—The flow and power as here given can be considerably increased during the ordinary working hours.

The next power is at Wendell Depot, and is owned by the Goddard Pulp Company, which also leases power to the Farley Paper Company. The former of these also runs a pulp-mill, mainly for grinding spruce and poplar. Four double grinding-machines are operated, requiring about 200 horse-power; 35 hands are employed, and the production of the mill is about 2 tons of pulp and 2½ tons of paper per day. The Farley company makes principally card middles. The dam at this privilege is of crib-work filled with stone. It has a width of 40 feet at the base, is not far from 10 feet high, and rests partly on ledge rock and partly on gravel. The fall at the mill is 15 feet. A total of 375 horse-power is run 24 hours in the day, and even during the dry summer of 1882 there was always water enough for running at full capacity, except occasionally for a day or two when mills happened to shut down above. The dam now throws the water back about a quarter of a mile, but an addition of 5 feet to its height is contemplated, which would give a pond some 2 miles long, setting back nearly or quite to Orange.

Of the main privilege at Orange seven-eighths is owned without question by the New Home Sewing Machine Company; the remaining one-eighth is involved in some dispute. The dam is a very old log structure, and the stream above is so flat that backwater extends for 3 or 4 miles, or to the lower part of the village of Athol. The mills are located immediately adjacent to the dam, and obtain a fall of from 7 to 9 feet. The New Home company uses 100 horse-power of wheels and employs 525 men. This company is supplied with castings by the Orange Iron Foundery Company, and the two concerns are operated together; the latter employs 120 men. The Chase Turbine Manufacturing Company's works and Levi Kilbourn & Co.'s chair-factory also use small powers from the same privilege. The New Home company uses steam in low water, but for about ten months in the year can run by water-power alone. A short distance down stream a low wing-dam diverts water to the Orange Furniture Company's factory, where 3 or 4 feet fall and a small power are employed.

Athol, the next point on the river, is a large and pleasant village, and has quite a manufacturing interest sustained by the water-power of the river. In what may be considered the village proper there are four dams on Miller's river, in the following order, ascending:

1. In the upper part of the village the river divides so as to inclose an island. A low cheap dam across the left-hand channel turns water into a small race, which is carried over to the course of Mill brook, a little stream flowing through the place. Power is then obtained by damming this brook at two or three points so as to give successive falls. A little water is received from the brook, but the main dependence is upon Miller's river. There are three falls on the privilege. At the first C. F. Richardson has a small machine-shop, and is said to use an undershot wheel with 2 or 3 feet fall. The second fall is mainly owned by Ethan Lord, who runs in connection with it a small saw-mill and cloth-mill. W. Lord also has power for a 3-run grist-mill and an elevator, and the Downes & Adams Silk Manufacturing Company owns about 30 horse-power. The heads in use range from 8 to 10 feet. The third fall on the brook is used by the Athol Machine Company, which has 11 feet head and 33 horse-power, by the Athol Blanket Company, and by Fred. Cheney, manufacturer of cotton-batting.

2. The second privilege in order on the main river is improved by a log dam about 100 feet long built on a rock ledge, and is owned by the Athol Mill Company, running 4,000 spindles on satinet warps and towelings. This company has 17 feet fall and about 175 horse-power of wheels, but does not use more than half their capacity. A small power is rented to L. S. Sterret, who makes machinists' tools, and to George M. Gerry & Son for their machine-shop. A building has also been erected for the manufacture of sashes and blinds, to be supplied with power from this privilege, and there is still for rent surplus power, estimated at 75 horse-power in a low stage of water. The entire power of the privilege may be estimated as below:

Estimate of power at the Athol Mill Company's privilege.

Stage of river.	Rainfall on basin.					Drainage area.	Flow per second, average for the 24 hours.	Theoretical horse-power.		Effective horse-power utilized.
	Spring.	Summer.	Autumn.	Winter.	Year.					
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Sq. miles.*	*Cubic feet.*	1 *foot fall.*	17 *feet fall.*	
Low water, dry year	13	12	12	11	48	207	120	13.63	230	100±
Low water, average year							140	15.90	270	
Available 10 months, average year							160	18.18	310	

NOTE.—Pondage at points above is sufficient to increase considerably the flow and power here given, during part of the day, in low stages.

3. A short distance up stream a low dam of loose stones turns water into a race, from which it is drawn under about 12 feet head to furnish power for a couple of small saw-mills and a blind- and shutter-shop. Mr. James M. Cheney owns the privilege and would like to sell it. He states that here, as well as at other privileges in this vicinity on Miller's river, there is, on account of the small pondage, a scarcity of water in the forenoon at times during the dry season, it being held back through the night in the large pond at Royalston. With 12 feet fall, the theoretical horse-power of Cheney's privilege may be estimated as follows: In low water of a dry year, 160 horse-power; in low water of an average year, 190 horse-power; and for the amount available 10 months in an average year, 220 horse-power.

4. The last privilege in the village of Athol, and the farthest up stream which was examined, is owned by the Miller's River Manufacturing Company, which manufactures horse-blankets and satinets, and uses 17 feet fall and one wheel of 108 horse-power. This company estimates its fall equivalent to 250 horse-power in a medium low stage of river. The dam was built about the year 1867, rests on ledge rock, and has a roll-way about 20 feet high and 200 feet long; it is a log structure with sloping face, and is supplemented by about 300 feet of dry-stone work.

Summary of water-privileges on Miller's river, from Athol to the mouth.

Locality.	Firm.	Manufacture.	Fall.	Remarks.
			Feet.	
Athol	Miller's River Manufacturing Company.	Horse-blankets and satinets	17	Uses 108 horse-power.
Do	Power owned by J. M. Cheney	Power used by 2 saw-mills and a blind- and shutter-shop.	12	Privilege for sale.
Do	Power owned by Athol Mill Company.	Power used for manufacture of satinet warps and towelings, and by two machine-shops and a sash and blind factory.	17	Surplus power for rent.
Do	C. F. Richardson	Machine-shop	2-3	These concerns are on the line of a race which strikes off from Miller's river to Mill brook, and then follows down the course of the latter, the falls given being those obtained on the race and brook.
Do	Ethan Lord	Saw-mill and cloth-mill	8-10	
Do	W. Lord	Grist-mill and elevator		
Do	Downes & Adams Silk Manufacturing Company.	Silk		
Do	Athol Machine Company	Machine-shop	11	
Do	Athol Blanket Company	Blankets		
Do	F. Cheney	Cotton-batting		
Orange	Orange Furniture Company	Pine chamber suits	3-4	Small power obtained by wing-dam.
Do	New Home Sewing Machine Company.	Sewing-machines	7-9	Seven-eighths of privilege owned by New Home Sewing Machine Company.
Do	Chase Turbine Manufacturing Company.	Turbines and circular saws		
Do	L. Kilbourn & Co	Chairs		
Wendell Depot	Goddard Pulp Company	Pulp and paper	15	375 horse-power in use night and day, with nearly always sufficient water. An addition of 5 feet to the height of the dam is contemplated.
Do	Farley Paper Company	Card middles		
Between Wendell Depot and Erving.	J. Stone & Sons	Piano-cases and saw-mill	10	Turn out $50,000 worth of piano-cases yearly. Surplus power for disposal. It is stated that dam can be raised 5 feet.
Erving	E. H. Spring	Grist-mill, and makes pail-staves	9-12	Small power.
Do	Washburn & Heywood Chair Company.	Cane- and wood-seat chairs, sashes and doors, and wooden pails.		Owns half the privilege, and uses 200 horse-power of wheels. Turns out about 600 chairs and 300 pails per day.
Do	Noah Rankine	Wood-seat chairs		Uses small power.
Erving to Miller's Falls		Unimproved	200+	This is not all to be considered available for use, on account of the narrow character of the valley, but several good powers could undoubtedly be obtained; in particular at a point a mile or two below Erving, where there is a fine open site, and just above Miller's Falls, where the Miller's Falls Company owns two falls, of about 15 and 30 feet, respectively.
Miller's Falls	Miller's Falls Company	Bits, braces, and vises, and general hardware.	32	Employs 150 men. Privilege is in two falls of 16 feet each.
Do	Lester & Lyman Manufacturing Company.	Hardware		Uses tail-water from upper mill.
Do	W. J. Phelps	Grist-, planing-, and saw-mill and wheelwright-shop.		Do.
Mouth of river	Privilege owned by James H. Brown.	Unimproved	25±	One-half mile from New London Northern railroad and about 4 miles by road from Turner's Falls.

TRIBUTARIES OF THE CONNECTICUT RIVER IN NEW HAMPSHIRE AND VERMONT.

Above Miller's river the Connecticut receives numerous tributaries from either side in New Hampshire and Vermont, no less than fifteen of which drain upward of 100 square miles each. It is to be regretted that lack of time forbade any examination of these streams, otherwise than by visits to a few scattered points in the summer of 1880. As to the New Hampshire streams, a brief report upon their value and availability for water-power was made to the governor and council of the state in 1870 by three commissioners. In that report are included a general discussion as to the advantages presented by the state for manufacturing by water-power, and returns from various towns briefly setting forth the extent to which power was already in use, estimates of the number of available unimproved privileges, and occasionally some other data, such as the amount of fall to be obtained, or the position with reference to important markets. In Hitchcock's *Geology of New Hampshire*, published in 1874, much valuable information is contained bearing upon the water-power of the state. The climatology is reported upon, an extended series of elevations is given (many of them for points on the water-courses), and some facts are included as to the locations, approximate size, and altitudes of the principal lakes and ponds.

In the documents and official reports brought before the general assembly of Vermont in 1876 is a paper by Mr. Henry Clark, presenting a few facts concerning some of the streams in that state, and rehearsing the leading characteristics of the water-powers in almost exactly the same words employed in the New Hampshire report of 1870.

From these various sources of information, and from the results of personal examinations and inquiries, an attempt will now be made to give some of the principal data regarding the upper tributaries of the Connecticut. It is to be noticed that although many of these streams are short, flowing down drainage slopes which seldom depart more than 15 or 20 miles on the east, or from 25 to 30 miles on the west side, from the main river, their fall is large even at a

considerable distance below the head-waters. To illustrate by a single example: Sugar river, in New Hampshire, has its principal source in Sunapee lake, and thence to the mouth is an important mill stream; yet in its course of only 22 miles from the lake to the Connecticut river it descends 810 feet. The Connecticut river itself, in its course through and past New Hampshire, ranges in elevation above sea-level from 2,000 down to 200 feet, while, according to Dr. Hitchcock, its eastern water-shed line has an average elevation of nearly 4,000 feet from mount Madison to Moosilauke mountain, and of about 1,500 feet thence southward to the Massachusetts line. The lowest point in this entire line is stated to be at Orange summit, on the Northern railroad, where the altitude is 990 feet.

Of equal importance with the fall are the volume of water and the steadiness with which it is maintained. The mountainous, and often rocky, character of the surface in this part of the Connecticut basin of itself favors an uneven and poorly-sustained flow. But there are certain features which tend to offset the unfavorable condition of steep slopes, the principal of which are the greater rainfall of the elevated regions; the retaining of snow for a long time among the mountains and the gradual release of water by its melting; the wooded nature of a large part of the surface; the fact, stated by Dr. Hitchcock, that the "mountains, especially the higher summits, except where it has been destroyed by fire, are covered to a considerable depth by peat, formed chiefly from moss and lichens", which acts to interrupt the too rapid drainage of surface-water; and, in a very important degree, the presence of numerous natural lakes and ponds. Not only do these last in their natural condition have a very beneficial effect in holding back freshets, and by the warmth of their waters preventing, to a considerable extent, troubles from ice, but they also in many cases offer opportunity for raising their surfaces by dams, and for thus greatly enlarging their storage—such an important factor in the development of the New England rivers.

The principal streams of the section here described have convenient railroad communication with tide-water, the mountainous character of the country compelling the lines to follow the river valleys. The distances by rail of some of the more prominent points from important seaports and markets are shown below:

Distances by rail from tide-water of points in the upper Connecticut basin.

Locality.	To Portland.	To Portsmouth.	To Boston.	To New York.
	Miles.	*Miles.*	*Miles.*	*Miles.*
Keene, New Hampshire	.....	.....	90	210
Bellows Falls, Vermont	.....	.....	112	220
Claremont, New Hampshire	.....	116	132	238
Lebanon, New Hampshire	.....	124	140	265
Woodstock, Vermont	.....	.....	155	270
Saint Johnsbury, Vermont	136	.....	189	321

Although, in the aggregate, a great number of water-privileges are in use on the New Hampshire and Vermont tributaries of the Connecticut, there can be no difficulty in finding good unimproved sites in almost any section; and it is true there, as elsewhere in New England, that many valuable privileges are occupied by small saw- and grist-mills which use but an insignificant part of the available power.

The Ashuelot river has a length by general course of from 40 to 45 miles, and a drainage area of 422 square miles. The main branch has its source on the northern boundary of the town of Washington, in Sullivan county, New Hampshire; it runs thence southwesterly and empties into the Connecticut in the town of Hinsdale, Cheshire county. Keene, with a population of 6,800, is the principal point on the stream. From Keene to the mouth the Ashuelot railroad follows closely the course of the river. The Ashuelot is sustained by several reservoirs controlled by mill-owners, and by a considerable number of natural ponds and lakes, the larger of which are mentioned in the table below. It is to be noticed that four of these, containing in the aggregate about 1,150 acres, have an average elevation of 1,300 feet above tide, or 1,100 feet greater than the mouth of the river.

Principal lakes and ponds in the basin of the Ashuelot river.

Name of pond.	Approximate area.	Elevation above sea-level.	Locality (town).	Outlet.
	Acres.	*Feet.*		
Sand pond (*a*)	172	.....	Washington	Small stream to main river.
Ashuelot pond (*a*)	233	1,300	do	Ashuelot river.
Munsonville pond	*b* 300	1,350	Nelson and Stoddard	Small stream to Otter river.
Woodward pond	*b* 230	1,300	Roxbury and Nelson	Roaring brook.
Breed pond	*b* 200	1,250	Harrisville and Nelson	Small stream to Pratt brook.
Monadnock lake	*b* 260	.....	Dublin	Pratt brook.
Round pond (*c*)	150	.....	Winchester	Small stream to main river.

a Storage reservoirs controlled by Messrs. Faulkner & Colony, of Keene; areas as stated by them.
b Measured by planimeter on Hitchcock's map of New Hampshire.
c Artificial reservoir controlled by stone dam 100 feet long and 15 feet high, built in 1873 at a cost of $3,200.

At the Cheshire Railroad crossing, near Keene, the water-surface of the river has an elevation of 469 feet above tide; the elevation at the mouth of the river is 206 feet, so that in the intervening distance of 21 miles, by river, there is a total descent of 263 feet, or an average of 12½ feet to the mile.

The country adjoining the river between the mouth and Keene is fairly well wooded. The valley is narrow at Hinsdale, but widens out above. At the former point the stream itself ranges from 100 to 200 feet in width. The bed and banks are usually gravelly, and the flow is quite well sustained.

Ascending the stream we find two water privileges in use at Hinsdale, but a short distance from the mouth. The lower is improved by a wooden dam 175 feet long and 10 feet high, built about 1860. A canal 250 feet long carries water to the Brightwood paper-mills, using 12 feet head and 75 horse-power, and to the cotton and woolen factory of Messrs. Haile, Frost & Co., using 12 feet head and 150 horse-power. The latter concern has sufficient water throughout the year, but the Brightwood mills are short at times.

At the upper privilege is a wooden dam, about fifty years old, 180 feet long by 6 feet high. A race perhaps half a mile long conveys water to Robertson & Son's paper-mill, to C. T. Amidon's cotton and woolen factory, and to two machine-shops. The fall in use ranges from 11 to 30 feet, and about 330 horse-power of wheels are employed.

At Turner's village and Ashuelot, power is employed in the manufacture of cotton-warps and beavers, and at West Swanzey are the Stratton woolen-mills, using 9 feet head and 200 horse-power. At Keene, Messrs. Faulkner & Colony have a woolen factory run by power from the Ashuelot. The dam is of wood, and is about 90 feet long and 15 feet high. Eleven feet head and 100 horse-power are in use at the factory.

Three and one-half miles above Hinsdale there is a stated to be a good unimproved privilege, where, with a canal 500 feet long, 27½ feet fall is available. The corresponding power may be estimated as follows:

Estimate of unimproved power 3½ miles above Hinsdale.

Stage of river.	Rainfall on basin.					Drainage area.	Flow per second, average for the 24 hours.	Theoretical horse-power.	
	Spring.	Summer.	Autumn.	Winter.	Year.				
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Sq. miles.*	*Cubic feet.*	*1 foot fall.*	*27½ feet fall.*
Low water, dry year	11¼	12	12½	10½	46½	393	125	14.20	390
Low water, average year							150	17.04	470
Available 10 months, average year							210	23.86	660

NOTE.—Pondage along the stream would, doubtless, considerably increase the power here during part of the day, but no data are at hand indicating to what extent.

On the main stream above Keene, and on various tributaries, are many minor privileges occupied by saw-mills, as well as an abundance of unimproved sites.

West river rises in the towns of Weston and Peru, Vermont, from 20 to 25 miles northwesterly from Bellows Falls. It runs southeasterly through Windham county, and empties into the Connecticut immediately above Brattleboro'. From Londonderry, in the upper waters, to the mouth, it is followed by the Brattleboro' and Whitehall division of the Central Vermont railroad. Its length is about 36 miles, and its drainage area 363 square miles. It is utilized for power by various wood-working establishments.

Williams river is a small stream emptying into the Connecticut from the Vermont side 3 miles above Bellows Falls. Drainage area, 103 square miles. The Central Vermont railroad follows the course of the stream on its way from Bellows Falls to Rutland. Power is used by a number of small saw-mills and wood-working establishments.

Black river rises in the town of Plymouth, Vermont, and runs southeasterly through the towns of Ludlow, Cavendish, Weathersfield, and Springfield, in each of which there are thriving villages where power is used. The manufactures embrace cotton and woolen goods, lumber, flour, and various articles of wood. The stream has a drainage area of 152 square miles, and in its course passes through a number of ponds. For a half-dozen miles in its middle course it is followed closely by the Central Vermont railroad, but elsewhere it is from 5 to 7 miles distant from it.

Sugar river has its principal source in Sunapee lake, a splendid sheet of water, 7½ miles long, and 2½ miles wide in the broadest part, lying upon the boundary between Sullivan and Merrimack counties, New Hampshire. The river runs westerly, with a length of about 22 miles, passing successively across the towns of Sunapee, Newport, and Claremont, in the latter of which it empties into the Connecticut. The drainage basin of the stream includes 272 square miles. The principal tributaries are Goshen branch, which joins the main stream from the south at Newport, and Croydon branch, entering from the north at Northville.

Sunapee lake has an area of about 5,900 acres, and an elevation above tide of 1,090 feet at low water and 1,103 feet at high water. It also receives the drainage from Otter pond, 270 acres, and Little Sunapee lake, 510 acres. On the Croydon branch is Eastman's pond, of about 280 acres. The drainage area above the outlet of

Sunapee lake is 47 square miles. The fine storage afforded by this great reservoir, and the large fall of about 800 feet thence to the Connecticut river, combine to render Sugar river a splendid manufacturing stream, well sustained in the dry season, and free from hinderances by freshets or ice. The Concord and Claremont railroad follows the stream most of the way from the lake to the mouth. A large amount of manufacturing is supported by the stream, comprising cotton and woolen goods, paper, flour, lumber, and a variety of wooden implements and wares.

Claremont, a few miles from the mouth, is the most important point on the stream. The entire town contains a population of 4,700, and within its limits are, as nearly as can be ascertained, the following water-privileges on Sugar river:

1. Several miles above Claremont village, possibly beyond the limits of the town, 20 feet fall, rated at 175 horse-power, unimproved.

2. In Claremont, upper privilege owned by Monadnock Mills, 7½ feet fall.

3. Lower privilege, 16½ feet fall, in use by Monadnock Mills, running 160 horse-power.

4. Privilege with 14 feet fall used by the Sullivan Machine Company, which owns 100 horse-power, but actually employs less than one-third that amount. The remainder of the privilege is said to be owned by the Claremont Manufacturing Company and the Monadnock Mills.

5. Privilege with 12 feet fall, one-half owned and used by the Claremont Manufacturing Company, paper. The remainder is occupied by the Home cotton-mill and Eastman's tannery, the latter not in operation.

6. Fall of 14 feet. Power used by saw-mill, grist-mill, stair-rail factory, and two novelty works.

The river here divides into two channels separated by an island. On one of these, a fall said to amount to about 60 feet (*a*) is but slightly used by small shops. Continuing on the main river, we have:

7. Fall of 22½ feet, owned by the Sugar River paper-mill; 150 horse-power used, and as much more not in use.

8. Old furnace privilege, about 10 feet fall, unimproved.(*a*)

9. Fall of 13 feet, not used.(*a*)

10. Fall of 8 or 10 feet, used by woolen-mill and hosiery-mill.

11. Lower falls, "undeveloped, and of somewhat uncertain value".(*a*)

12. "From this point to the site of the old Russell carpet-mill could probably be erected one or two dams, though the banks are not so favorable for that purpose as could be wished."(*a*)

13. Fall of 12 or 15 feet, not used.(*a*)

14. At West Claremont, 18 or 20 feet fall, used for paper-, saw-, and grist-mills.(*a*)

Ottaquechee river.—This stream rises near the western boundary of Windsor county, Vermont, and runs easterly across the towns of Bridgewater, Woodstock, and portions of Hartford and Hartland, joining the Connecticut 3 or 4 miles below White River Junction. It has a length of about 40 miles by general course, and a drainage area of 192 square miles. Woodstock village, having a population of 1,300, is the most important point on the stream, and is reached by a short line of railroad from White River Junction.

Only a little way from the mouth a high ledge crosses the river and forms an island in the center. A log dam has been built from either side of this island to the adjacent shore, and on the right bank is a small saw-mill, and on the left the satinet factory of the Ottaquechee Woolen Company. Nine sets of cards are run, and 300 horse-power of wheels used under a head of 26 feet.

Five or six miles up stream, at the village of Quechee, A. G. Dewey & Co. have a 6-set woolen-mill, and J. C. Parker & Co. one of 7 sets. At numerous other points along the course of the stream small powers are in use by saw-mills and various wood-working shops, where are manufactured such articles as agricultural implements, chairs, wooden handles, sashes, doors, and blinds.

The river is described as a good one for manufacturing purposes. It has a reservoir in its upper waters, and is well sustained in flow. The Ottaquechee woolen factory can be run at full capacity at all times, with unimportant exceptions; 2 or 3 feet of backwater is said to be experienced there during high freshets in the Connecticut.

A mile up stream the proprietors of this factory own a fall of 30 feet, which has been in use but is now unoccupied.

The descent of the river is rapid, amounting to an average of very nearly 30 feet per mile for the lower 30 miles of its course. The fall is shown more in detail in the following table, kindly furnished by Mr. Hosea Doton, engineer of the Woodstock railroad:

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a Report on the water-power of the state, made in 1870.

Table showing the fall in the Ottaquechee river.(a)

Locality.	Distance above mouth.	Elevation of water-surface above water in Connecticut river.	Distance between points.	Fall between points.	Fall per mile between points.
	Miles.	*Feet.*	*Miles.*	*Feet.*	*Feet.*
Pond in the river at Sherburne	30	883			
			3	111	
Bowl factory near West Bridgewater	27	772			39.5
			1	47	
Chair factory at West Bridgewater	26	725			
			3	66	
Pond at Wood's mills	23	659			
			2	74	32.0
Saw-mill pond	21	585			
			2	84	
Factory pond at Bridgewater	19	501			
			5	99	
Daniels' machine-shop, West Woodstock	14	402			18.8
			1	14	
Factory pond at Woodstock	13	388			
			4	68	
Taftsville pond	9	320			20.1
			3	73	
Parker's factory pond at Quechee	6	247			
			1	49	
Factory pond at Dewey's mills	5	198			
			¼	52	
Railroad crossing near Dewey's mills	4¾	146			
			3¾	61	41.2
Head of Wood's falls	1	85			
			¾	55	
Pond at Quechee falls	¼	30			
			¼	30	
Connecticut river, water-surface	0	0			

a Mr. Doton gives the elevation of the Connecticut river above sea-level as 305 feet. This does not agree with elevations obtained elsewhere, and therefore heights along the Ottaquechee are here given with reference to water-surface at its mouth.

The Mascomy river rises in the western part of the town of Dorchester, Grafton county, Vermont; it runs southerly for about 9 miles, then turns abruptly to the west, and a few miles farther on enters Mascomy lake, a fine sheet of water 4 miles long and from one-quarter to three-quarters of a mile wide. Issuing from the lake, the river resumes its westerly course to the Connecticut, passing across the town of Lebanon. It drains 148 square miles above the outlet of Mascomy lake, and 190 square miles above its own mouth.

The most important lakes and ponds in the drainage basin, with their approximate elevations above tide, and areas, are as follows:

Mascomy lake; elevation, 750 feet; area, 1,400 acres.

Crystal lake; elevation, 900 feet; area, 380 acres.

Hart's pond; elevation, 1,050 feet; area, 450 acres.

Goose pond; area, 370 acres.

Norris pond; elevation, 1,500 feet; area, 330 acres.

In the distance of 8½ miles from Mascomy lake to the Connecticut the river falls about 406 feet, or say 48 feet to the mile. The Northern railroad follows the stream through the principal part of its course, and at Lebanon station is at an elevation of 510 feet above tide.

Lebanon is an important village about 4 miles from the mouth of the Mascomy river, with a population of 2,000. Manufacturing by water-power is carried on there and at numerous other points along the stream, the productions including iron-castings, machinery, watch and clock materials, lumber, woolen goods, paper, and various articles in wood. In the report upon the water-power of the state made in 1870, it was stated that in the town of Lebanon the value of the work annually turned out by water-power was at that time half a million dollars. In the same report the discharge of the stream at the lowest stage was given as about 134 cubic feet per second. Messrs. Mead, Mason, & Co., at Lebanon, manufacturers of sashes, doors, and blinds, use 18 feet fall and 325 horse-power of wheels, and state that they have sufficient water throughout the year for running their works at full capacity.

There are reported to be several unimproved falls in Lebanon, two privileges improved and with buildings, but unoccupied, and two unimproved falls at East Lebanon.

White river rises in the towns of Hancock and Granville, Addison county, Vermont, runs southeasterly, receiving in succession the Third, Second, and East branches, and enters into the Connecticut at White River Junction. The Central Vermont railroad follows its course from the mouth to Bethel, and then passes up the Third branch. The stream has a drainage area of 623 square miles, ranking third in this respect among the tributaries of the Connecticut. Mr. Henry Clark, of Rutland, says of this stream: "From its source it runs slowly through a narrow tract of intervale until it arrives at Stockbridge, after which the current is very rapid until it reaches Bethel village. From Bethel to its mouth the channel of the river is from 16 to 18 rods in width, and the current generally rapid and the water shallow." As usual on the streams in this section, power is used by a number of saw- and grist-mills, and by blacksmithing, cooperage, and wood-working shops. There is said to be considerable available power in the village of Bethel.

The Ompomponoosuc river drains 123 square miles, mainly in Orange county, Vermont, and empties into the Connecticut river 4 miles above White River Junction. It is stated to offer fine facilities for the use of power, but is without railroad communication except at the mouth. A number of small powers are in use by saw-mills and shops.

Wait's river lies entirely in Orange county, Vermont, through which it runs southeasterly to the Connecticut river. It has a length of 15 or 18 miles by general course, and a drainage area of 156 square miles. It is without railroad facilities except as it is crossed at the mouth by the Passumpsic railroad. It furnishes power to a variety of small establishments, mainly in the town of Bradford, where there are reported to be numerous unimproved falls.

The Lower Ammonoosuc river is formed by small branches the most remote of which drain the western slope of mount Washington. It flows westerly and then southwesterly, with a length by general course of about 40 miles, and joins the Connecticut at Woodsville. Its basin includes 388 square miles. The principal affluents are from the south, and among these the most important are the South branch and the Wild Ammonoosuc. The Boston, Concord, Montreal, and White Mountains railroad follows the course of the stream throughout its length. On the lower river the principal points are Woodsville, at the mouth, population, 400; Lisbon, 800; and Littleton, 1,700. The fall is large, as seen in the following table:

Table showing the fall in the Lower Ammonoosuc river.

Locality.	Distance from mouth.	Elevation above tide.	Approximate fall between points.	Distance between points.	Fall per mile between points.	Remarks.
	Miles.	*Feet.*	*Feet.*	*Miles.*	*Feet.*	
Ammonoosuc station, base of mount Washington	45	2,668	1,339	13	103.0	Elevations by profile of Boston, Concord, Montreal, and White Mountains railroad.
Lower Ammonoosuc at mouth of Little river.....	32	1,329				
Mouth of river	0	407	922	32	28.8	Elevation as given in *Geology of New Hampshire.*

At present the river is not sustained by any storage reservoirs, and is very variable in flow, a heavy rain causing a large and rapid rise. The bed and banks are generally rocky, and the latter high, though between Woodsville and Bath there are some meadow-lands. Toward the mouth the width between banks is from 100 to 200 feet.

The manufacturing is mainly in the towns of Lisbon and Littleton, and is carried on by a number of saw-mills, grist-mills, tanneries, and wood-working shops of different kinds. The lowest privilege in use on the river is at Bath, where Conant & Co. have a pulp-mill; 14½ feet fall and 350 horse-power of wheels are in use here, and in low water the wheels can be run at about one-half capacity. Directly at the mouth of the stream there is an unoccupied privilege, formerly in use, where 8 or 10 feet fall might easily be obtained; and, according to the report on the water-power of the state, there are at least three other unimproved falls on the river within the limits of the town of Bath.

Wells river rises in a series of ponds in the towns of Groton, Peacham, and Marshfield, Vermont. It flows southeasterly to the Connecticut, into which it empties nearly opposite the Lower Ammonoosuc. It has a length by general course of about 15 miles and a drainage area of 94 square miles. Of the ponds mentioned in the upper waters the largest is Long pond, which has a length of over 2 miles, and a width of about three quarters of a mile in the broadest part. The stream is followed by the Montpelier and Wells River railroad, and is described as being generally rapid and affording good powers. Its present use is mainly confined to saw- and grist-mills, of which there are over a dozen along its course.

The Passumpsic river is made up by small branches rising in the northern part of Caledonia county, Vermont. It takes a southerly course through the county, and unites with the Connecticut in the town of Barnet. It is 25 or 30 miles long by general course, and drains an area of 485 square miles. The principal affluents are the East branch and Moose river from the east, and Miller's run, Sleepy river, Andric and Lee's brooks from the west. The Passumpsic railroad follows the course of the main stream throughout, while the Burlington and Lamoille line crosses the basin from west to east and runs up the valley of Moose river. The principal points on the main river are Saint Johnsbury, some 8 miles from the mouth, having a population of 3,400, and Lyndon, as much farther above, with 800 inhabitants.

The Passumpsic is described as a generally swift stream, well suited to manufacturing purposes, but subject to considerable fluctuations in volume. The country drained is well supplied with springs, however, and the dry-season flow of the stream is tolerably well sustained. The bed and banks are rocky, and the opportunities are fairly good for securing large pondage at dams.

The first power in use, ascending the stream, is at East Barnet, only a short distance from the mouth. A horseshoe-shaped dam crosses the river here on ledges over which there is a natural fall, and gives a head of 29 feet at Wilder & Co.'s mill. They manufacture wood-pulp from spruce, and use three wheels having a total capacity of about 1,100 horse-power. It is stated that this amount of power can be obtained nine months in an

average year, but for the remainder of the time there is a shortage, and in lowest water only about one-half capacity can be realized. Wilder & Co. own all of this privilege except 100 horse-power at the opposite end of the dam, which is used in part by J. D. Gould for the manufacture of croquet and chair stock.

Some of the more important powers above on the stream, so far as could be learned by correspondence, are as follows:

At Saint Johnsbury there is a fine privilege with 12 feet fall, only a small portion of the power of which is in use by the Saint Johnsbury Granite Company and a carriage-shop. The dam was built in 1854, is a log and stone structure about 250 feet long and 10 feet high, and is stated to have cost in all $30,000.

In Lyndon there are at least four important falls. Wilder's pulp-mill has 61 feet head and 1,500 horse-power. The A. A. Pierce & Son paper-mill returns 13 feet fall and 1,000 horse-power, which it is evident can be realized only a part of the year. The Lyndon Lumber Company has from 13 to 18 feet fall, a pond estimated at 100 acres, and uses 200 horse-power; and Burke's flouring-mill has 11 feet fall and 36 horse-power. Numerous other powers are in use on the main stream and its tributaries, principally by saw- and grist-mills and wood-working shops. Undoubtedly there are many available unoccupied powers on these streams, but only only two were mentioned in particular—one of 20 feet fall, which it was said could be obtained on the lower Moose river by a short canal, and one of 15 feet fall, 2 miles below Saint Johnsbury, the power of which may be estimated as follows:

Estimate of power 2 miles below Saint Johnsbury.

Stage of river.	Rainfall on basin.					Drainage area.	Flow per second, average for the 24 hours.	Theoretical horse-power.	
	Spring.	Summer.	Autumn.	Winter.	Year.				
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Sq. miles.*	*Cubic feet.*	1 *foot fall.*	15 *feet fall.*
Low water, dry year	9½	12	11	8½	41	410	120	13.63	200
Low water, average year							160	18.18	270
Available 10 months, average year							240	27.26	410

John's river and *Israel's river* are two streams heading 5 or 10 miles northwesterly from mount Washington and descending to the Connecticut. John's river drains 86 square miles, includes in its basin several ponds of 150 or 200 acres each, the most important being Long, Island, and Cherry ponds, and is followed by the Boston, Concord, Montreal, and White Mountains railroad, but is used only for two or three small saw-mill powers.

Israel's river drains 129 square miles, is without natural ponds in its basin or a railroad along its course, but is used for power by 8 or 10 saw- and grist-mills, a paper-mill, machine-shop, and one or two wood-working shops.

The Upper Ammonoosuc river heads in the Pond of Safety, in the town of Randolph, Coos county, New Hampshire, at an altitude of 1,975 feet above sea-level. It runs in an irregular northerly direction, and then turns to the west, reaching the Connecticut river in the town of Northumberland. Its drainage area includes 252 square miles, within which are the following principal ponds:

Larger ponds tributary to the Upper Ammonoosuc river.

Name of pond.	Area. (*a*)	Elevation above tide.
	Acres.	*Feet.*
Head pond	330	1,075
Percy pond	350	1,040
Potter's pond	360	1,025
Trio ponds	270	1,960

a By planimeter measurement on state map.

The principal tributaries of the river are Dead river, Philip's brook, and Nash's stream. The main stream is followed from the mouth to West Milan by the Grand Trunk railway. The only use of power is by a few saw-mills, a grist-mill, and a machine-shop.

Table showing the fall in the Upper Ammonoosuc river.

Locality.	Distance above mouth.	Elevation above tide.	Fall between points, approximate.	Fall per mile between points.	Remarks.
	Miles.	*Feet.*	*Feet.*	*Feet.*	
Pond of Safety	33	1,975	960	56.5	Altitude as given by Dr. Hitchcock.
West Milan	16	1,015	89	11.9	Elevation of rails, Grand Trunk Railway.
Railroad crossing near Stark	8½	926	60	10.0	Water-surface by Grand Trunk Railway levels.
Railroad crossing near Groveton	2½	866			Water-surface by Grand Trunk Railway levels.

The Nulhegan river joins the Connecticut from the west, draining the northern portion of Essex county, Vermont. Its basin comprises 132 square miles. Its course is followed by the Grand Trunk railway, but no returns of power used are at hand.

Hall's stream, 88 square miles drainage area; *Indian stream*, 67 square miles; and *Perry stream*, 27 square miles, are small tributaries which the Connecticut receives from the north in the extreme upper part of New Hampshire. They are not directly reached by any railroad, and no information has been gained that they are in any way used for power, except that a single small saw-mill power is returned for Perry stream.

Table of utilized power on the Connecticut river and its tributaries.

Stream.	Tributary to what.	State.	County.	Kind of mill or manufacture.	Number of mills.	Total fall utilized.	Total water-power utilized.	Auxiliary steam-power.	Remarks.
						Feet.	*H. P.*	*H. P.*	
Connecticut river	Long Island sound	Connecticut	Hartford	Paper	3	(a)	1,080		Windsor Locks.—Total water-power utilized, 1,800 to 1,900 horse-power.
Do	do	do	do	Iron and steel	1		250	170	
Do	do	do	do	Cotton	1		100		
Do	do	do	do	Hosiery	1		50		
Do	do	do	do	Silk	1		10		
Do	do	do	do	Wool grading and scouring	1				
Do	do	do	do	Rubber rollers	1		225		
Do	do	do	do	Machinery	3		36		
Do	do	do	do	Flour and grist	1		45		
Do	do	do	do	Saw	1		30		
Do	do	Massachusetts	Hampden	Paper bags	1	(b)	4		Holyoke. Total water-power utilized at Holyoke and South Hadley Falls, in 1880, as here enumerated, 12,260 horse-power. In October, 1882, the amount in use was stated at about 15,000 effective horse-power.
Do	do	do	do	Leather belting and hose	1		6		
Do	do	do	do	Brick and tile	1		16		
Do	do	do	do	Carpentering	1		15		
Do	do	do	do	Cotton	5		3,016	65	
Do	do	do	do	Cutlery and edge-tools	1		40		
Do	do	do	do	Fertilizers	1		10		
Do	do	do	do	Files	1		3		
Do	do	do	do	Flour and grist	1		80		
Do	do	do	do	Lithographing	1		1		
Do	do	do	do	Planing	1		40		
Do	do	do	do	Mattresses and spring beds	1		2		
Do	do	do	do	Mucilage and paste	1		10		
Do	do	do	do	Machinery	8		288		
Do	do	do	do	Paper	17		6,315	23	
Do	do	do	do	Rubber and elastic goods	1		60		
Do	do	do	do	Sashes, doors, and blinds	1		15		
Do	do	do	do	Screws	1		80		
Do	do	do	do	Shoddy	1		150		
Do	do	do	do	Silk	1		100		
Do	do	do	do	Steam fitting and heating apparatus	1		6		
Do	do	do	do	Wirework	2		140		
Do	do	do	do	Wood turning and carving	1		5		
Do	do	do	do	Wood-pulp	1		120		
Do	do	do	do	Woolen	4		663		
Do	do	do	do	Worsted	2		550		
Do	do	do	Hampshire	Cotton	1	26–32	250		South Hadley Falls, opposite Holyoke.
Do	do	do	do	Paper	2		275		
Do	do	do	Franklin	Cotton	1	(c)	75		Turner's Falls. Total water-power utilized in 1880, as here enumerated, 4,320 horse-power.
Do	do	do	do	Cutlery and edge-tools	1		675		
Do	do	do	do	Leather-board	1		15		
Do	do	do	do	Paper	3		3,290		
Do	do	do	do	Machinery	1		50		
Do	do	do	do	Saw	1		215		Opposite Turner's Falls.
Do	do	Vermont	Windham	Agricultural implements	1	(d)	30		Bellows Falls.—Total water-power utilized in 1880, as here enumerated. 4,210 horse-power. Up to October, 1882, this amount had been increased, as nearly as can be ascertained, by introduction of two new mills and increasing the power at the old ones, to 7,040 horse-power, of which 6,847 was employed in paper manufacture.
Do	do	do	do	Flour and grist	1		98		
Do	do	do	do	Machinery	1		30		
Do	do	do	do	Paper	4		4,017		
Do	do	do	do	Picture-molding	1		20		
Do	do	do	do	Planing and sawing	1		15		

a Falls range from 20 to 26 feet.

b Total fall on Holyoke privilege, 56 to 59 feet, utilized from three levels.

c Falls range from 20 to 41 feet.

d Total fall on privilege about 52 feet, utilized from two levels.

Table of utilized power on the Connecticut river and its tributaries—Continued.

Stream.	Tributary to what.	State.	County.	Kind of mill or manufacture.	Number of mills.	Total fall utilized.	Total water-power utilized.	Auxiliary steam-power.	Remarks.
						Feet.	*H. P.*	*H. P.*	
Connecticut river	Long Island sound.	Vermont	Caledonia	Saw	1	12	360 to 450		McIndoe's Falls.
Do	do	New Hampshire.	Grafton	Flour and grist	1				
Do	do	Vermont	Essex	Saw	1	10	120		
Do	do	New Hampshire.	Coos	do	2	21	80		
Do	do	do	do	Flour and grist, saw, and starch.	1	10	100		
Salmon river	Connecticut river.	Connecticut	Middlesex	Cotton	1	17½	70		
Do	do	do	New London	Paper	2	27	140		
Do	do	do	do	Flour and grist	1	17	22		
Tributaries	Salmon river	do	Middlesex	Bells	7	61+	99		
Do	do	do	do	Coffins and undertakers' goods.	4	74	235	30	
Do	do	do	do	Cotton-duck	2	59	136		
Do	do	do	do	Cotton twine and yarns	10	275	477+	85	
Do	do	do	do	Flour and grist	1	28	15		
Do	do	do	do	Hardware	1	20	15		
Do	do	do	do	Machinery	1	12	10		
Do	do	do	do	Paper	1				
Do	do	do	do	Plated and britannia ware	1	48	30	40	
Do	do	do	do	Saw	3	75	80		
Do	do	do	do	Thread and silk	1	20			
Do	do	do	New London	Sashes, doors, and blinds	1	10	10		
Do	do	do	Tolland	Flour and grist	1	25	16		
Do	do	do	Hartford	do	1	18	18		
Do	do	do	do	Saw	3	62	59		
Hockanum river	Connecticut river.	do	Tolland	Cotton	5	254	1,300 to 1,400	840	Rockville (see description).
Do	do	do	do	Envelopes	1				
Do	do	do	do	Silk	1				
Do	do	do	do	Woolen	6				
Do	do	do	do	do	1	24½	125		
Do	do	do	do	Paper	1	10	40		
Do	do	do	Hartford	Cotton	1	20	250	100	
Do	do	do	do	Paper	7	104	1,107	500+	
Tributaries	Hockanum river	do	Tolland	Carpentering	2	20	38		
Do	do	do	do	Cotton	2	38	66	60	
Do	do	do	do	Flour and grist	3	46	110		
Do	do	do	do	Saw	4	69	95		
Do	do	do	do	Shoddy	2	71	120		
Do	do	do	do	Woolen	1	21	60	40	
Do	do	do	Hartford	Cotton	3	76	70	65	
Do	do	do	do	Flour and grist	1	18	20		
Do	do	do	do	Machinery	1	9	10		
Do	do	do	do	Needles and pins	1	10	8	8	
Do	do	do	do	Paper	8	219+	202	297	
Do	do	do	do	Silk	1	36	52	758	
Do	do	do	do	Woolen	2	14+	40	65	
Farmington river	Connecticut river.	do	do	Worsted	1	7½	96		Poquonock.
Do	do	do	do	do	1	9	400	50	Do.
Do	do	do	do	Paper	1				Do.
Do	do	do	do	do	3	10-13	350		Rainbow.
Do	do	do	do	Horse-blankets	1	8	16		Spoonville.
Do	do	do	do	Silk	1	13	100		Tariffville (300 horse-power of wheels).
Do	do	do	do	Flour and grist	1	5	40		Farmington.
Do	do	do	do	Cutlery and edge-tools	1	(a)	750	50+	Unionville (about 1,000 horse-power, total, leased in 1882).
Do	do	do	do	Hardware	1				
Do	do	do	do	Iron bolts and nuts	1				
Do	do	do	do	Paper	4				
Do	do	do	do	Turning	1				
Do	do	do	do	Flour, grist, and saw	1	9½	50		Unionville; intermediate privilege.
Do	do	do	do	Agricultural implements, edge-tools, etc.	1	20	1,150	(?)	Collinsville.
Do	do	do	Litchfield	Cotton-duck, furniture, hardware, brass and iron foundery, grist and saw.	1	17	480±		Pine Meadow.
Do	do	do	do	Machinery, castings, and tools.	1				

a Two levels, 18 feet fall from each.

Table of utilized power on the Connecticut river and its tributaries—Continued.

Stream.	Tributary to what.	State.	County.	Kind of mill or manufacture.	Number of mills.	Total fall utilized.	Total water-power utilized.	Auxiliary steam-power.	Remarks.
						Feet.	*H. P.*	*H. P.*	
Farmington river	Connecticut river	Connecticut	Litchfield	Cotton	1	30	800	.....	New Hartford.
Do	do	do	do	Cotton	1	18	170	100	Colebrook river.
Do	do	do	do	Rules	1	8	20	.....	
Do	do	do	do	Paper	1	12	135	.....	
Do	do	do	do	Saw	1	12	40	.....	
Do	do	do	do	Sashes, doors, and blinds	1	7½	15	.....	
Do	do	Massachusetts	Hampden	Saw	1	16	75	.....	
Do	do	do	do	Tannery	1	12	24	.....	
Do	do	do	Berkshire	Agricultural implements	1	9	24	.....	
Do	do	do	do	Saw	7	83	214	.....	
Do	do	do	do	Tannery	1	12	10	.....	
Do	do	do	do	Wooden packing-boxes	1	12	35	.....	
Do	do	do	do	Wood turning and carving	1	.....	11	.....	
Pequabuck river and tributaries.	Farmington river.	Connecticut	Hartford	Brassware	1	22, 12	87	345	
Do	do	do	do	Carriage and wagon materials.	1	24	10	.....	
Do	do	do	do	Clocks	6	75½	135	221	
Do	do	do	do	Cutlery and edge-tools	1	10	30	.....	
Do	do	do	do	Flour and grist	2	28	41	.....	
Do	do	do	do	Hardware	6	100	106	19	
Do	do	do	do	Hosiery	2	19+	57	65	
Do	do	do	do	Machinery	1	12	10	10	
Do	do	do	do	Saw	1	22	20	.....	
Do	do	do	do	Saws manufactured	1	5½	25	.....	
Do	do	do	do	Sewing-machine materials and repairs.	1	8	15	.....	
Do	do	do	do	Stationery goods	1	8	15	.....	
Do	do	do	do	Stencils and brands	1	11	16	.....	
Do	do	do	do	Wood turning and carving	2	22	23	.....	
Do	do	do	do	Watch and clock materials	5	71	36	20	
Do	do	do	Litchfield	Flour and grist	1	26	16	.....	
Do	do	do	do	Iron castings	1	12	15	.....	
Do	do	do	do	Saw	2	25	18	.....	
Still river and tributaries.	do	do	do	Agricultural implements	5	82	444	120	
Do	do	do	do	Wooden packing-boxes	1	12	10	.....	
Do	do	do	do	Coffins and undertakers' goods.	1	8	38	35	
Do	do	do	do	Clocks	1	18	72	.....	
Do	do	do	do	Cutlery and edge-tools	3	71	170	50	
Do	do	do	do	Flour and grist	2	19	63	.....	
Do	do	do	do	Furniture	1	15	70	.....	
Do	do	do	do	Hardware	1	18	80	10	
Do	do	do	do	Iron bolts, etc	1	15	60	80	
Do	do	do	do	Iron forgings	2	37	73	75	
Do	do	do	do	Machinery	1	6	18	.....	
Do	do	do	do	Needles and pins	1	9	54	40	
Do	do	do	do	Printing and publishing	2	.....	6	.....	
Do	do	do	do	Saw	3	68	40+	.....	
Do	do	do	do	Springs	1	16	45	.....	
Do	do	do	do	Tanneries	3	28	70	15	
Do	do	do	do	Turning	2	67	50+	.....	
All other tributaries.	do	do	Hartford	Carriage and wagon materials.	1	7	15	.....	
Do	do	do	do	Cutlery and edge-tools	1	24	24	.....	
Do	do	do	do	Explosives and fire-works	1	8	100	30	
Do	do	do	do	Furniture	1	7	5	.....	
Do	do	do	do	Flour and grist	5	72	110	8	
Do	do	do	do	Hardware	1	18	40	.....	
Do	do	do	do	Machinery	1	13	25	.....	
Do	do	do	do	Paper	1	28	24	10	
Do	do	do	do	Saw and cotton	1	6	56	.....	
Do	do	do	do	Saw	19	326	555	.....	
Do	do	do	do	Wood turning and carving	3	55	75	.....	
Do	do	do	do	Wheelwrighting	1	.....	5	.....	
Do	do	do	do	Woolen	1	24	18	.....	

Table of utilized power on the Connecticut river and its tributaries—Continued.

Stream.	Tributary to what.	State.	County.	Kind of mill or manufacture.	Number of mills	Total fall utilized.	Total water-power utilized.	Auxiliary steam-power.	Remarks.
						Feet.	*H. P.*	*H. P.*	
All other tributaries.	Farmington river.	Connecticut	Litchfield.....	Agricultural implements .	1	15	20	.....	
Do.....	....do	....do	... do	Blacksmithing.....	1	12	20	.....	
Do.....	....do	....do	....do	Flour and grist	2	13+	43	.....	
Do.....	....do	....do	....do	Iron forgings	1	8	25	.....	
Do.....	....do	....do	... do	Ivory and wood rules.....	1	13, 14	107	.....	
Do.....	....do	....do	....do	Saw	11	159	288	.....	
Do.....	....do	....do	....do	Wood turning and carving	3	41	57	.....	
Do.....	....do	Massachusetts..	Berkshire ...	Agricultural implements..	2	19	21	.....	
Do.....	....do	....do	....do	Cooperage	1	8	25	.....	
Do.....	....do	....do	....do	Furniture	1	10	8	.....	
Do.....	....do	....do	....do	Saw	7	140	123	.....	
Do.....	....do	....do	....do	Whips and lashes.....	1	.....	15	.....	
Scantic river and tributaries.	Connecticut river.	Connecticut	Hartford	Fertilizers	1	6	12	.....	
Do.....	....do	....do	....do	Flour and grist	5	65	265	.....	
Do.....	....do	....do	....do	Gunpowder.....	1	62½	300	240	
Do.....	....do	....do	....do	Paper	1	12	42	.....	
Do.....	....do	....do	....do	Saw	3	36	55	.....	
Do.....	....do	....do	....do	Woolen	2	38	148	260	
Do.....	....do	....do	Tolland.....	Flour, grist, and saw	1	15½	27	.....	
Do.....	....do	....do	....do	Saw	3	67	70	.....	
Do.....	....do	....do	....do	Woolen	2	23	90	.....	
Do.....	....do	Massachusetts..	Hampden.....	Flour and grist	1	20	18	.....	
Do.....	....do	....do	....do	Woolen.....	3	52	95	160	
Mill river.....	....do	....do	....do	Cotton-waste	2	28	65	25	
Do.....	....do	....do	....do	Fire-arms	1	32	175	100	
Do.....	....do	....do	....do	Flour and grist	2	26½	100	.....	
Do.....	....do	....do	....do	Hardware	1	.....	80	.....	
Do.....	....do	....do	....do	Silk.....	1	11	75	.....	
Do.....	....do	....do	....do	Woolen	1	10	60	.....	
Westfield river and tributaries.	....do	....do	....do	Baskets, rattan- and willow-ware.	1	11	9	.....	
Do.....	....do	....do	....do	Blacksmithing.....	1	10	12	.....	
Do.....	....do	....do	....do	Boots and shoes.....	1	16	32	.....	
Do.....	....do	....do	....do	Cigars	1	5	12	.....	
Do.....	....do	....do	....do	Cigar-boxes.....	1	5	22	.....	
Do.....	....do	....do	....do	Cardboard	1	30	31	.....	
Do.....	....do	....do	....do	Carpentering	1	24	6	8	
Do.....	....do	....do	....do	Coffin-trimmings.....	1	.....	.....	.....	
Do.....	....do	....do	....do	Cotton	1	32	350	.....	West Springfield.
Do.....	....do	....do	....do	Cotton-waste	1	10	.....	.....	
Do.....	....do	....do	....do	Emery-wheels	1	.....	.....	.....	
Do.....	....do	....do	....do	Findings.....	1	14	46	.....	
Do.....	....do	....do	....do	Flour and grist	5	67	220+	.....	
Do.....	....do	....do	....do	Furniture	2	20	60	.....	
Do.....	....do	....do	....do	Gunpowder.....	2	24	31	.....	
Do.....	... do	... do	... do	Kaolin and ground earths.	3	32	122	.....	
Do	....do	....do	....do	Machinery.....	2	25	62	.....	
Do.....	....do	....do	....do	Paper.....	5	86	1,412	540	
Do.....	....do	....do	... do	....do	a2	.....			
Do.....	....do	....do	....do	Printing and publishing ..	5	30+	7	.....	
Do.....	....do	....do	....do	Saw	8	98	233	.....	
Do.....	....do	....do	....do	Shoe-pegs, etc.....	1	9	.....	.....	
Do.....	....do	....do	....do	Steam-heating apparatus..	1	.....	12	.....	
Do.....	... do	....do	....do	Tanneries	3	54	80	.....	
Do.....	....do	....do	....do	Thread	1	10	.....	.....	
Do.....	....do	....do	....do	Toys and games	1	16	15	.....	
Do.....	....do	....do	....do	Watch and clock repairing	1	28	1	.....	
Do.....	....do	....do	....do	Whips and whip materials.	12	10+	18+	.....	
Do.....	....do	....do	....do	Wooden ware.....	1	8	12	.....	
Do.....	....do	....do	Hampshire ...	Baskets, rattan- and willow-ware.	1	11	7	.....	
Do.....	....do	....do	....do	Children's carriages and sleds	1	10	14	.....	
Do.....	....do	....do	....do	Cooperage	2	60	45	.....	
Do.....	....do	....do	....do	Cutlery and edge-tools....	1	14	6	.....	

a West Springfield; fall stated above.

Table of utilized power on the Connecticut river and its tributaries—Continued.

Stream.	Tributary to what.	State.	County.	Kind of mill or manufacture.	Number of mills.	Total fall utilized.	Total water-power utilized.	Auxiliary steam-power.	Remarks.
						Feet.	*H. P.*	*H. P.*	
Westfield river and tributaries.	Connecticut river.	Massachusetts.	Hampshire	Flour and grist	4	64	141		
Do	do	do	do	Furniture	1	12	8		
Do	do	do	do	Lock- and gun-smithing	2	32	50		
Do	do	do	do	Machinery	1	40	40		
Do	do	do	do	Paper	4	91	485	90	
Do	do	do	do	Saw	17	285	448		
Do	do	do	do	Tools	1	13	12		
Do	do	do	do	Wooden handles	5	71	94		
Do	do	do	do	Wood turning and carving	7	92+	193		
Do	do	do	do	Woolen	3	67	118	120	
Do	do	do	Berkshire	Blacksmithing	1	18	6	5	
Do	do	do	do	Cutlery and edge-tools	1	19	20		
Do	do	do	do	Flour and grist	1	18	32		
Do	do	do	do	Iron castings	1	19	6		
Do	do	do	do	Paper	1	27	50	20	
Do	do	do	do	Saw	4	66	90	65	
Do	do	do	do	Wood turning and carving	3	47	38		
Do	do	do	do	Wooden ware	1	30	12		
Chicopee river	do	do	Hampden	Agricultural implements	2		110	60	
Do	do	do	do	Carpet yarns, crashes, twines, and bagging.	4	30	700		Ludlow Manufacturing Company.
Do	do	do	do	Cotton	11	106	4,902	1,150	These mills are owned by four different companies, as follows: 4 by the Dwight Manufacturing Company, 4 by the Chicopee Manufacturing Company, 2 by the Indian Orchard Mills, and 1 by the Otis Company.
Do	do	do	do	Flour and grist	2		105	150	
Do	do	do	do	Machinery	1	9	66	17	
Do	do	do	do	Paper	1	13	513		
Do	do	do	do	Swords	1				
Do	do	do	do	Tools, sewing-machines, and bronze statuary.	1		100–200		
Quaboag river and tributaries.	Chicopee river	do	do	Flour and grist	2	23	35		
Do	do	do	do	Shoddy	1	10			
Do	do	do	do	Woolen	6	99	250	300	
Do	do	do	Worcester	Blacksmithing	1	5	4		
Do	do	do	do	Carriage and wagon materials.	2	14	20		
Do	do	do	do	Cotton	4	53	685		Including 3 mills at West Warren.
Do	do	do	do	Cutlery and edge-tools	1	12	80		
Do	do	do	do	Flour and grist	9	127	236		
Do	do	do	do	Saw	12	174	426		
Do	do	do	do	Wire	1	60	180		
Do	do	do	do	Wooden packing-boxes	2	33	45	60	
Do	do	do	do	Woolen	3	20+	210	60	
Ware river and tributaries.	do	do	Hampden	Cotton	2	39	610		Thorndike Company.
Do	do	do	Hampshire	do	3	63	750±	80	Otis Company.
Do	do	do	do	Flour and grist	1	11	20		
Do	do	do	do	Saw	1	11	25		
Do	do	do	do	Woolen	1	7			
Do	do	do	do	do	1		150		
Do	do	do	Worcester	Agricultural implements	3	40	44		
Do	do	do	do	Baskets	1	8	20		
Do	do	do	do	Chairs	5	132	96		
Do	do	do	do	Cotton	1	19	135		
Do	do	do	do	Flour and grist	7	100	228		
Do	do	do	do	Hats and caps	1	12	30	25	
Do	do	do	do	Hones and whetstones	1	12	8		
Do	do	do	do	Saw	24	340+	813	35	
Do	do	do	do	Tannery	1	8	30		
Do	do	do	do	Tools	1	16	15		
Do	do	do	do	Wheelbarrows	1	10	15		
Do	do	do	do	Wooden packing-boxes	1	14			

Table of utilized power on the Connecticut river and its tributaries—Continued.

Stream.	Tributary to what.	State.	County.	Kind of mill or manufacture.	Number of mills.	Total fall utilized.	Total water-power utilized.	Auxiliary steam-power.	Remarks.
						Feet.	*H. P.*	*H. P.*	
Ware river and tributaries.	Chicopee river.	Massachusetts.	Worcester.	Wood turning and carving.	2	34	8	.....	
Do.	do	do	do	Woolen	2	38-40	600	125	Gilbertville.
Swift river and tributaries.	do	do	Hampden.	Cotton	1	21	493	160	Bondsville.
Do.	do	do	Hampshire.	Agricultural implements	1	11	25	.....	
Do.	do	do	do	Cotton	1	8	35	.....	
Do.	do	do	do	Flour and grist	3	43	133	.....	
Do.	do	do	do	Saw	16	192	373	25	
Do.	do	do	do	Sporting goods	1	22	15	.....	
Do.	do	do	do	Wooden packing-boxes	1	7½	12	.....	
Do.	do	do	do	Wood turning and carving.	1	15	6	.....	
Do.	do	do	do	Woolen	2	27	150	35	
Do.	do	do	Worcester.	Billiard and bagatelle tables, cues, and materials.	1	7	25	.....	
Do.	do	do	do	Saw	6	63	181	.....	
Do.	do	do	do	Soapstone	1	20	125	.....	
Do.	do	do	do	Wooden packing-boxes	1	7	36	.....	
Do.	do	do	Franklin.	Flour and grist	2	22	65	.....	
Do.	do	do	do	Saw	7	91	182	.....	
Sundry small tributaries.	do	do	Hampden.	Bricks and tiles	1	12	12	20	
Do.	do	do	do	Flour and grist	2	29	88	.....	
Do.	do	do	do	Saw	2	40	45	.....	
Do.	do	do	do	Woolen	1	22	40	40	
Do.	do	do	do	Worsted	1	9	45	45	
Do.	do	do	Worcester.	Woolen	3	76	195	195	
Mill river.	Connecticut river.	do	Hampshire.	Agricultural implements.	1	14	120	100	
Do.	do	do	do	Brass goods	1	18	65	.....	
Do.	do	do	do	Buttons	4	54	109	85	
Do.	do	do	do	Cotton	2	46	185	125	
Do.	do	do	do	Cutlery and edge-tools	2	32	197	200	
Do.	do	do	do	Emery-wheels	1	14	15	10	
Do.	do	do	do	Flour and grist	2	27	67	.....	
Do.	do	do	do	Paper	1	.....	.....	.....	
Do.	do	do	do	Saw	1	18	33	.....	
Do.	do	do	do	Silk	3	.....	100-200	85±	Nonotuck Silk Company.
Do.	do	do	do	Tape	1	.....	30	.....	
Do.	do	do	do	Wire-work	1	10	25	.....	
Do.	do	do	do	Woolen	1	16	115	50	
Deerfield river and tributaries.	do	do	Franklin.	Bits and gimlets	1	.....	25	30	
Do.	do	do	do	Cotton	4	111	571	405	
Do.	do	do	do	Cutlery and edge-tools	1	25	350	.....	
Do.	do	do	do	Files	1	16	6	.....	
Do.	do	do	do	Flour and grist	14	224	371	.....	
Do.	do	do	do	Hardware	1	32	22	.....	
Do.	do	do	do	Machinery	1	8	6	.....	
Do.	do	do	do	Musical instruments and materials.	1	8	25	.....	
Do.	do	do	do	Saw	28	473+	816	.....	
Do.	do	do	do	Tanneries	3	26+	28	15	
Do.	do	do	do	Wood turning and carving	8	139	150	.....	
Do.	do	do	do	Woolen	1	18	50	40	
Do.	do	do	Berkshire.	Saw	1	29½	225	.....	Hoosac Tunnel.—Full power of wheels as here given not in use.
Do.	do	do	do	Machinery	1				
Do.	do	Vermont.	Windham.	Children's carriages and sleds.	1	.....	50	20	
Do.	do	do	do	Chairs	1	20	25	.....	
Do.	do	do	do	Flour and grist	6	113	157	.....	
Do.	do	do	do	Furniture	1	24	45	.....	
Do.	do	do	do	Sashes, doors, and blinds	1	10	7	.....	
Do.	do	do	do	Saw	24	436	806	20	
Do.	do	do	do	Tannery	1	10	10	15	
Do.	do	do	do	Wheelwrighting	1	20	10	.....	
Do.	do	do	do	Wood turning and carving	2	20	24	.....	
Do.	do	do	Bennington.	Furniture	5	93	274	40	

Table of utilized power on the Connecticut river and its tributaries—Continued.

Stream.	Tributary to what.	State.	County.	Kind of mill or manufacture.	Number of mills.	Total fall utilized.	Total water-power utilized.	Auxiliary steam-power.	Remarks.
						Feet.	*H. P.*	*H. P.*	
Deerfield river and tributaries.	Connecticut river.	Vermont	Bennington	Saw	5	86	199		
Do	do	do	do	Tannery	1	14	25		
Do	do	do	do	Wood turning and carving	1	9	35		
Do	do	do	do	Wooden ware	1	85	40		
Miller's river and tributaries.	do	Massachusetts	Franklin	Chairs	6	59	351		
Do	do	do	do	Flour and grist	4	22+	140		
Do	do	do	do	Furniture	3	23	57		
Do	do	do	do	Hardware	2	16	230		
Do	do	do	do	Iron castings	1		40		
Do	do	do	do	Machinery	1		15		
Do	do	do	do	Piano materials	1	10	100		
Do	do	do	do	Sashes, doors, and blinds	1		15		
Do	do	do	do	Saw	11	115+	292		
Do	do	do	do	Sewing-machines	1	8	100	40	
Do	do	do	do	Wood-pulp and paper	2	15	375		
Do	do	do	do	Wooden packing-boxes	3	38	67		
Do	do	do	do	Wood turning and carving	2	24	29		
Do	do	do	do	Wooden ware	2		33		
Do	do	do	do	Woolen	1	9	35		
Do	do	do	Worcester	Brooms and brushes	1	4	12		
Do	do	do	do	Chairs	22	335	866	540	Mainly on Otter river.
Do	do	do	do	Children's carriages and sleds.	2	26	97	20	
Do	do	do	do	Cotton	4	31+	187+		
Do	do	do	do	Fancy articles	1	14	10		
Do	do	do	do	Flour and grist	7	103	208		
Do	do	do	do	Furniture	6	112	170	95	
Do	do	do	do	Hardware	1	14	3		
Do	do	do	do	House-furnishing goods	1	7	5		
Do	do	do	do	Horse-clothing	1	8	2	6	
Do	do	do	do	Iron castings	2	15	25		
Do	do	do	do	Machinery	8	71	249	17	
Do	do	do	do	Matches	1	32	50	25	
Do	do	do	do	Paper	1	16	93	80	
Do	do	do	do	Painting and paper-hangings.	1		6		
Do	do	do	do	Sashes, doors, and blinds	3	24+	55+		
Do	do	do	do	Saw	30	398	1,328	15	
Do	do	do	do	Shoddy	1		6		
Do	do	do	do	Silk	1		30		
Do	do	do	do	Tannery	1	10	50		
Do	do	do	do	Tools	1				
Do	do	do	do	Toys and games	3	26	52		
Do	do	do	do	Wheelwrighting	2	16	9		
Do	do	do	do	Window blinds and shades	2	30	80		
Do	do	do	do	Wooden packing-boxes	2	22	36		
Do	do	do	do	Wood turning and carving	3	25	22		
Do	do	do	do	Wooden ware	9	150	650	70	
Do	do	do	do	Woolen	5	72	518	95	
Do	do	New Hampshire	Cheshire	Cooperage	1	12	50		
Do	do	do	do	Flour and grist	2	22	54		
Do	do	do	do	Saw	16	236	543	65	
Do	do	do	do	Toys and games	1	14	15		
Do	do	do	do	Wheelwrighting	1	11	13		
Do	do	do	do	Wooden packing-boxes	3	36	58	60	
Do	do	do	do	Wooden handles	1	12	50		
Do	do	do	Hillsborough	Saw	1	12	31		
Ashuelot river and tributaries.	do	do	Cheshire	Agricultural implements	1	20	20		
Do	do	do	do	Brooms and brushes	1	8	10		
Do	do	do	do	Chairs	3	58	200	40	
Do	do	do	do	Cooperage	12	143+	248	45	
Do	do	do	do	Cotton	4±				Manufacture woolen goods also, and probably included in that class.

Table of utilized power on the Connecticut river and its tributaries—Continued.

Stream.	Tributary to what.	State.	County.	Kind of mill or manufacture.	Number of mills.	Total fall utilized.	Total water-power utilized.	Auxiliary steam-power.	Remarks.
						Feet.	*H. P.*	*H. P.*	
Ashuelot river and tributaries.	Connecticut river.	New Hampshire.	Cheshire	Cutlery and edge-tools	1	7	30		
Do	do	do	do	Fancy and paper boxes	1	6	34	30	
Do	do	do	do	Flouring and grist	5	51	158		
Do	do	do	do	Hosiery, woolen	1	12	35		
Do	do	do	do	Iron bolts, nuts, washers, and rivets.	1	12	2	2	
Do	do	do	do	Iron castings	1	13	5		
Do	do	do	do	*Machinery*	3	44	70		
Do	do	do	do	Paper	2	34	244		
Do	do	do	do	Planing	2	27	32		
Do	do	do	do	Sashes and blinds	1	9	20		
Do	do	do	do	Saw	48	616	1,310	45	
Do	do	do	do	Stone and earthen ware	2	28	31	15	
Do	do	do	do	Tanneries	4	29	53		
Do	do	do	do	Toys and games	1	5	10		
Do	do	do	do	Wirework	1	10	12		
Do	do	do	do	Wooden packing-boxes	11	96	239	14	
Do	do	do	do	Wooden ware	3	43	75		
Do	do	do	do	Woolen	12	164	956	315	
Do	do	do	Sullivan	Saw	3	21	90		
Sugar river and tributaries.	do	do	do	Agricultural implements	1	12	65		
Do	do	do	do	Blacksmithing	1	10	15		
Do	do	do	do	Boot- and shoe-findings	1	7	9		
Do	do	do	do	Cooperage	1		2		
Do	do	do	do	Cotton	1	16½	300		
Do	do	do	do	Excelsior	2	26	120		
Do	do	do	do	Files	1	11	30		
Do	do	do	do	Flouring and grist	6	77	689		
Do	do	do	do	Hosiery	2	22	62		
Do	do	do	do	Iron castings	1	8	15		
Do	do	do	do	Leather tanned and curried.	3	36	75		
Do	do	do	do	Machinery	1	8	10		
Do	do	do	do	Paper	3	61	255	50	
Do	do	do	do	Printing and publishing	1		8		
Do	do	do	do	Saddlery and harness	1	11	30		
Do	do	do	do	Saw	26	345	836		
Do	do	do	do	*Wood turning and carving*	3	46	83		
Do	do	do	do	Wooden handles	3	23	65		
Do	do	do	do	Wooden ware	6	62	97		
Do	do	do	do	Woolen	5	62½	410		
Mascomy river and tributaries.	do	do	Grafton	Agricultural implements	1	13	20		
Do	do	do	do	Blacksmithing	1		5		
Do	do	do	do	Brooms and brushes	3	32	24		
Do	do	do	do	Carpentering	1	12	28		
Do	do	do	do	Cooperage	2	18	58		
Do	do	do	do	Flouring and grist	7	100	320		
Do	do	do	do	Furniture	1	12	120		
Do	do	do	do	Hosiery	2	20	42		
Do	do	do	do	Iron castings	1	12	20		
Do	do	do	do	Machinery	2	25	55		
Do	do	do	do	Marble and stone work	1	7	10		
Do	do	do	do	Mattresses and spring beds	1	8	60		
Do	do	do	do	Paper	1	12	50	33	
Do	do	do	do	Sashes, doors, and blinds	1	12	25		
Do	do	do	do	Saw	17	217	599		
Do	do	do	do	Tannery	1	8	30		
Do	do	do	do	Watch and clock materials	1	13	20		
Do	do	do	do	Wheelwrighting	2	24	60		
Do	do	do	do	Wooden ware	1	6	30		
Do	do	do	do	Woolen	1	12			

Table of utilized power on the Connecticut river and its tributaries—Continued.

Stream.	Tributary to what.	State.	County.	Kind of mill or manufacture.	Number of mills.	Total fall utilized.	Total water-power utilized.	Auxiliary steam-power.	Remarks.
						Feet.	*H. P.*	*H. P.*	
Lower Ammonoosuc river and tributaries.	Connecticut river.	New Hampshire.	Grafton	Agricultural implements	1	16	120		
Do	do	do	do	Carpentering	1	17	20		
Do	do	do	do	Carriages and wagons	1	10	25		
Do	do	do	do	Cooperage	1	10	45		
Do	do	do	do	Flouring and grist	5	76	228		
Do	do	do	do	Gloves and mittens	1	16	150		
Do	do	do	do	Leather tanned and curried.	2	32	175		
Do	do	do	do	Machinery	1	13	25		
Do	do	do	do	Mattresses and spring beds.	1		20		
Do	do	do	do	Musical instruments and materials.	1		20		
Do	do	do	do	Sashes, doors, and blinds	1	14	35	25	
Do	do	do	do	Saw	18	213	890		
Do	do	do	do	Shoe-pegs	1	12	100		
Do	do	do	do	Spools and bobbins	4	34	90	15	
Do	do	do	do	Starch	2	17	35		
Do	do	do	do	Wheelwrighting	1	6	8		
Do	do	do	do	Wooden packing-boxes	1	15	20		
Do	do	do	do	Wood-pulp	2	14+	520		
John's river	do	do	Coos	Sashes, doors, and blinds	1	10	12		
Do	do	do	do	Saw	2		150	310	
Do	do	do	do	Wheelwrighting	1	12½	6		
Israel's river and tributaries.	do	do	do	Carriages and wagons	1	10	30		
Do	do	do	do	Flouring and grist	2	24	140		
Do	do	do	do	Furniture	1	6	15		
Do	do	do	do	Machinery	1	7	20		
Do	do	do	do	Paper	1	14½	25		
Do	do	do	do	Sashes, doors, and blinds	2	14	30		
Do	do	do	do	Saw	14	153	661	40	
Do	do	do	do	Starch	2	28	28		
Do	do	do	do	Wheelwrighting	1	6	15		
Do	do	do	do	Woolen	1	8	10		
Upper Ammonoosuc river and tributaries.	do	do	do	Flouring and grist	2	24	65		
Do	do	do	do	Machinery	1	5	3		
Do	do	do	do	Saw	10	117	420	150	
Mohawk river	do	do	do	Cooperage	1	10	2		
Do	do	do	do	Flouring and grist	1	13	70		
Do	do	do	do	Furniture	1	8	8		
Do	do	do	do	Iron castings	1	8	8		
Do	do	do	do	Machinery	1	8	10		
Do	do	do	do	Sashes, doors, and blinds	2	16	18	15	
Do	do	do	do	Saw	2	30	60		
Do	do	do	do	Starch	5	69	40		
Do	do	do	do	Wheelwrighting	1	8	5	8	
Do	do	do	do	Woolen	1	10	12		
West river and tributaries.	do	Vermont	Windham	Carriages and wagons	1	6	8		
Do	do	do	do	Chairs	1	12	20		
Do	do	do	do	Cooperage	6	86	101		
Do	do	do	do	Flouring and grist	6	86	129		
Do	do	do	do	Furniture	1	10	9		
Do	do	do	do	Leather tanned and curried.	2	21	98		
Do	do	do	do	Pickles, preserves, and sauces.	1	12	23		
Do	do	do	do	Saw	28	369	844	30	
Do	do	do	do	Wheelwrighting	3	33	16		
Do	do	do	do	Wood turning and carving	5	110	88		
Do	do	do	Bennington	Carriage and wagon materials.	1	12	8	12	
Do	do	do	do	Saw	10	170	370	35	

Table of utilized power on the Connecticut river and its tributaries—Continued.

Stream.	Tributary to what.	State.	County.	Kind of mill or manufacture.	Number of mills.	Total fall utilized.	Total horse-power utilized.	Auxiliary steam-power.	Remarks.
						Feet.			
West river and tributaries.	Connecticut river.	Vermont	Windsor	Cooperage	3	11+	47		
Do	do	do	do	Saw	6	28+	150	53	
Do	do	do	do	Toys and games	1		40		
Do	do	do	do	Wheelwrighting	1		15		
Do	do	do	do	Wooden handles	1		40		
Do	do	do	do	Woolen	1	20	20		
Saxton's river	do	do	Windham	Baskets, rattan- and willow-ware.	1	22	90	8	
Do	do	do	do	Carriage and wagon materials.	1	9	12		
Do	do	do	do	Flouring and grist	4	65	148		
Do	do	do	do	Leather tanned and curried.	1	20	25		
Do	do	do	do	Lumber planed	2	30	43		
Do	do	do	do	Marble and stone work	1	12	30		
Do	do	do	do	Saw	4	54	100		
Do	do	do	do	Wheelwrighting	1	11	12		
Do	do	do	do	Wood turning and carving	1	23	25		
Do	do	do	do	Woolen	2	45	95	58	
Williams river and tributaries.	do	do	do	Flouring and grist	1	18	75		
Do	do	do	do	Saw	1	18	25		
Do	do	do	do	Wood turning and carving	1	17	10		
Do	do	do	Windsor	*Children's carriages and sleds.*	1	10	12		
Do	do	do	do	Flouring and grist	3	54	106		
Do	do	do	do	Furniture	1	6½	8		
Do	do	do	do	Saw	2	34	85	15	
Do	do	do	do	Tannery	1	9	20	15	
Do	do	do	do	Wheelwrighting	1	7	10		
Black river and tributaries.	do	do	do	Agricultural implements	1	6½	22		
Do	do	do	do	Carpentering	1	87	42		
Do	do	do	do	Children's carriages and sleds.	3	39	156		
Do	do	do	do	Chairs	1	30	31		
Do	do	do	do	Cooperage	1	8	20		
Do	do	do	do	Cotton	2	43	121		
Do	do	do	do	Flouring and grist	13	208	441		
Do	do	do	do	Furniture	3	43	34		
Do	do	do	do	Hones and whetstones	1	18	15		
Do	do	do	do	Machinery	4	34½	44	15	
Do	do	do	do	Marble and stone work	1	10	20		
Do	do	do	do	Saw	18	315	646		
Do	do	do	do	Shoddy	1	28	40		
Do	do	do	do	Tannery	1	16	10		
Do	do	do	do	Toys and games	1	6	6		
Do	do	do	do	Wheelwrighting	1	10	5		
Do	do	do	do	Wood turning and carving	1	18	60		
Do	do	do	do	Wooden-ware	3	42	79		
Do	do	do	do	Woolen	5	76	340		
Ottaquechee river and tributaries.	do	do	do	Agricultural implements	4	45	125	10	
Do	do	do	do	Chairs	3	26	65		
Do	do	do	do	Cooperage	1	8	20		
Do	do	do	do	Flouring and grist	4	57	215		
Do	do	do	do	Sashes, doors, and blinds	3	45	37		
Do	do	do	do	Saw	9	121	376		
Do	do	do	do	Tannery	2	32	60	25	
Do	do	do	do	Wooden handles	2	24	110		
Do	do	do	do	Woolen	4	85	590	50	
Do	do	do	Rutland	Saw	2	40	125		
White river and tributaries.	do	do	Windsor	Agricultural implements	2	15	53		
Do	do	do	do	Blacksmithing	3	29	36		
Do	do	do	do	Buttons	1	18	40	30	
Do	do	do	do	Chairs	1	11	75		

Table of utilized power on the Connecticut river and its tributaries—Continued.

Stream.	Tributary to what.	State.	County.	Kind of mill or manufacture.	Number of mills.	Total fall utilized.	Total water-power utilized.	Auxiliary steam-power.	Remarks.
						Feet.	*H. P.*	*H. P.*	
White river and tributaries.	Connecticut river.	Vermont	Windsor	Cooperage	2	18	22		
Do	do	do	do	Flouring and grist	11	164	524		
Do	do	do	do	Hardware	1	7½	18		
Do	do	do	do	Lumber planed	3	53	72		
Do	do	do	do	Saw	28	394	939	25	
Do	do	do	do	Toys and games	1		20		
Do	do	do	do	Wheelwrighting	3	38	48		
Do	do	do	do	Wooden handles	2	16	50		
Do	do	do	Orange	Agricultural implements	5	53½	106		
Do	do	do	do	Blacksmithing	1	12	30		
Do	do	do	do	Carriages and wagons	1		8		
Do	do	do	do	Cooperage	1		31		
Do	do	do	do	Flouring and grist	6	65	287		
Do	do	do	do	Furniture	1	13	25		
Do	do	do	do	Leather tanned and curried.	2	21	18		
Do	do	do	do	Saw	14	179+	561		
Do	do	do	do	Wheelwrighting	2	9	150		
Do	do	do	do	Wooden handles	1	7½	8		
Do	do	do	do	Woolen	2	25	55		
Do	do	do	Addison	Saw	5	78	213		
Do	do	do	do	Woolen	1	8	12		
Do	do	do	Rutland	Flouring and grist	1	11	35		
Do	do	do	do	Saw	6	111	162		
Do	do	do	do	Wood turning and carving	1	17	20		
Ompomponoosuc river.	do	do	Windsor	Saw	1	10	60		
Do	do	do	Orange	Drugs and chemicals	1	16	50		
Do	do	do	do	Flouring and grist	1	8	30		
Do	do	do	do	Furniture	1	10	25	25	
Do	do	do	do	Saw	6	71	185		
Do	do	do	do	Sporting goods	1	10			
Do	do	do	do	Wheelwrighting	1	11	15		
Do	do	do	do	Woolen	1	30	40		
Wait's river and tributaries.	do	do	do	Blacksmithing	1	6	10		
Do	do	do	do	Cooperage	2	28	8+		
Do	do	do	do	Cordage and twine	1	15	32		
Do	do	do	do	Flouring and grist	6	93	131		
Do	do	do	do	Machinery	1	9			
Do	do	do	do	Sashes, doors, and blinds	1	18			
Do	do	do	do	Saw	13	174	341		
Do	do	do	do	Wheelwrighting	3	30	24+		
Do	do	do	do	Wood turning and carving	2	26	50		
Wells river and tributaries.	do	do	do	Blacksmithing	1	7			
Do	do	do	do	Flouring and grist	2	22	100		
Do	do	do	do	Furniture	1	7	25		
Do	do	do	do	Paper	1	18	70		
Do	do	do	do	Saw	3	38	110		
Do	do	do	do	Woolen	1	8	20		
Do	do	do	Caledonia	Flouring and grist	2	16½	68		
Do	do	do	do	Saw	7	100	235		
Passumpsic river and tributaries.	do	do	do	Agricultural implements	3	48	123		
Do	do	do	do	Carriages and wagons	1	8	40		
Do	do	do	do	Chair-stock, etc	1	29	100		
Do	do	do	do	Cutlery and edge-tools	1	10	4		
Do	do	do	do	Files	1	10	60		
Do	do	do	do	Flouring and grist	13	201	663		
Do	do	do	do	Furniture	2	26	36		
Do	do	do	do	Leather tanned and curried.	2	18	50		
Do	do	do	do	Machinery	2	32	45		
Do	do	do	do	Marble and stone work	2	40	40		
Do	do	do	do	Paper	2	25	1,090		

Table of utilized power on the Connecticut river and its tributaries—Continued.

Stream.	Tributary to what.	State.	County.	Kind of mill or manufacture.	Number of mills.	Total fall utilized.	Total water-power utilized.	Auxiliary steam-power.	Remarks.
						Feet.	*H. P.*	*H. P.*	
Passumpsic river and tributaries.	Connecticut river.	Vermont	Caledonia	Sashes, doors, and blinds	2	28	61	.....	
Do	do	do	do	Scales and balances	2	38	135	175	
Do	do	do	do	Saw	25	410	846	.....	
Do	do	do	do	Wheelwrighting	5	60	197	.....	
Do	do	do	do	Wood-pulp	3	107	2,750	.....	
Do	do	do	do	Wooden ware	3	37	135	.....	
Do	do	do	do	Woolen	2	28	58	.....	
Do	do	do	Essex	Flouring and grist	1	12	50	.....	
Do	do	do	do	Saw	12	221	502	.....	
Nulhegan river and tributaries.	do	do	do	do	1	12	240	.....	
Minor tributaries	do	Connecticut	Middlesex	Agricultural implements	2	128	250	.....	
Do	do	do	do	Brooms and brushes	2	64	26	.....	
Do	do	do	do	Buttons	1	8	3	.....	
Do	do	do	do	Coffins, burial-cases, and undertakers' goods.	1	11	10	.....	
Do	do	do	do	Cotton	3	59	250	550	
Do	do	do	do	Cutlery and edge-tools	3	42	123	30	
Do	do	do	do	Dyeing and cleaning	1	5	10	.....	
Do	do	do	do	Fertilizers	2	23½	31	.....	
Do	do	do	do	Flouring and grist	11	178	333	.....	
Do	do	do	do	Gunpowder	1	.....	8	.....	
Do	do	do	do	Hardware	11	189	173	39	
Do	do	do	do	Hooks and eyes	1	26	12	.....	
Do	do	do	do	Iron castings	1	.....	5	.....	
Do	do	do	do	Ivory and bone work	7	125	143	80	
Do	do	do	do	Lock- and gun-smithing	1	20	15	.....	
Do	do	do	do	Mattresses and spring beds	1	13	10	.....	
Do	do	do	do	Models and patterns	1	.....	2	.....	
Do	do	do	do	Mosquito- and fly-nets	1	6	20	20	
Do	do	do	do	Patent medicines and compounds.	3	51	20	.....	
Do	do	do	do	Sashes, doors, and blinds	1	13	10	.....	
Do	do	do	do	Saw	15	256	324	40	
Do	do	do	do	Stationery goods	2	19	24	.....	
Do	do	do	do	Tools	7	125	213	.....	
Do	do	do	do	Washing-machines and clothes-wringers.	1	37	32	40	
Do	do	do	do	Wheelwrighting	1	36	30	.....	
Do	do	do	do	Wirework	2	25	13	6	
Do	do	do	do	Wood turning and carving	2	21	35	.....	
Do	do	do	do	Wooden handles	1	16	25	.....	
Do	do	do	Hartford	Cigar-boxes	1	9	20	.....	
Do	do	do	do	Cotton	1	65	200	300	
Do	do	do	do	Fertilizers	1	9	20	.....	
Do	do	do	do	Flouring and grist	18	310	426	80	
Do	do	do	do	Furniture	1	15	10	.....	
Do	do	do	do	Hardware	1	32	115	.....	
Do	do	do	do	Hosiery	1	12½	27	25	
Do	do	do	do	Iron forgings	2	56	55	.....	
Do	do	do	do	Mattresses and spring beds	1	13	6	.....	
Do	do	do	do	Needles and pins	2	38	21	3	
Do	do	do	do	Paper	5	90	157	61	
Do	do	do	do	Saw	8	112	155	.....	
Do	do	do	do	Soap and candles	1	20	15	.....	
Do	do	do	do	Tannery	1	12	20	.....	
Do	do	do	do	Tools	1	4½	10	60	
Do	do	do	do	Watch and clock materials.	1	6	2	.....	
Do	do	do	do	Woolen	4	60+	186	140	
Do	do	Massachusetts	Hampden	Fancy articles	1	19	30	40	
Do	do	do	do	Flouring and grist	7	143	162	40	
Do	do	do	do	Saw	4	15+	53	.....	
Do	do	do	do	Woolen	1	20	15	30	
Do	do	do	Hampshire	Buttons	2	40	95	.....	

Table of utilized power on the Connecticut river and its tributaries—Continued.

Stream.	Tributary to what.	State.	County.	Kind of mill or manufacture.	Number of mills.	Total fall utilized.	Total water-power utilized.	Auxiliary steam-power.	Remarks.
						Feet.	*H. P.*	*H. P.*	
Minor tributaries..	Connecticut river.	Massachusetts..	Hampshire ...	Children's carriages and sleds.	2	24	13	.....	
Do	....do	....do	....do	Cotton	3	60	226	580	
Do	....do	... do	....do	Fire-arms	1	15	25	.....	
Do	....do	....do	... do	Flouring and grist	10	133	543	.....	
Do	....do	....do	....do	Lumber planed	2	16+	45	10	
Do	....do	....do	... do	Machinery	1	7	8	.....	
Do	....do	....do	....do	Paper	6	166	457	210	
Do	....do	....do	....do	Pumps	1	9	8	.....	
Do	....do	... do	....do	Rubber and elastic goods .	2	41	110	110	
Do	....do	....do	... do	Sashes, doors, and blinds..	1	12	12	.....	
Do	....do	....do	....do	Saw	18	243	475	.....	
Do	... do	....do	....do	Silk	2	20	25	8	
Do	....do	....do	....do	Tannery	1	20	8	.....	
Do	....do	....do	....do	Tools	1	10	10	.....	
Do	....do	....do	....do	Upholstering materials ...	1	22	20	.....	
Do	....do	....do	....do	Wheelwrighting	1	10	55	.....	
Do	....do	....do	....do	Whips	3	26	16	.....	
Do	....do	....do	....do	Wooden packing-boxes ...	2	35	50	12	
Do	....do	....do	Franklin.....	Agricultural implements .	2	26	52	.....	
Do	....do	....do	....do	Chairs	1	12	14	.....	
Do	....do	....do	....do	Flouring and grist	11	269	254	.....	
Do	....do	....do	....do	Furniture	1	14	12	.....	
Do	....do	... do	....do	Sashes, doors, and blinds .	2	28	20	.....	
Do	....do	....do	....do	Saw	30	557	834	20	
Do	....do	....do	....do	Wheelwrighting	1	40	8	.....	
Do	....do	....do	....do	Wood turning and carving.	3	26	50	.....	
Do	....do	....do	....do	Woolen	1	18	20	.....	
Do	....do	New Hampshire.	Cheshire.....	Cutlery and edge-tools	1	10	10	.....	
Do	....do	....do	....do	Fancy and paper boxes ...	1	12	25	30	
Do	....do	....do	....do	Flouring and grist	2	27	76	.....	
Do	....do	... do	....do	Paper	1	12	80	.....	
Do	....do	... do	....do	Planing	1	12	10	.....	
Do	....do	....do	....do	Sashes, doors, and blinds..	2	43	40	.....	
Do	....do	....do	....do	Saw	15	198	387	10	
Do	....do	....do	....do	Tin-, copper-, and sheet-iron ware.	1	9	60	.....	
Do	....do	....do	....do	Vinegar	1	.....	20	.....	
Do	....do	....do	....do	Wheelwrighting	1	11	5	.....	
Do	....do	....do	....do	Wood turning and carving.	1	14	40	.....	
Do	....do	....do	Sullivan	Carriages and wagons	1	3	68	.....	
Do	....do	....do	....do	Coffins, burial-cases, and undertakers' goods.	1	7	10	.....	
Do	....do	....do	... do	Cooperage	2	23+	59	.....	
Do	....do	.. do	... do	Flouring and grist	5	140	219	.....	
Do	... do	....do	....do	Saw	11	160	353	.....	
Do	....do	....do	... do	Shoe-pegs	1	9	55	.....	
Do	....do	....do	... do	Wooden handles	1	9	35	.....	
Do	....do	....do	....do	Woolen	2	31	54	.....	
Do	....do	....do	Grafton.....	Flouring and grist	6	138	351	.....	
Do	... do	....do	....do	Hones and whetstones	3	29+	137	.....	
Do	.. do	....do	....do	Paper	1	32	75	.....	
Do	....do	....do	....do	Saw	18	292	787	.....	
Do	....do	....do	....do	Starch	1	.....	12	.....	
Do	....do	....do	... do	Tannery	1	25	20	.....	
Do	... do	... do	... do	Wheelwrighting	2	38	38	.....	
Do	....do	....do	Coos	Flouring and grist	5	69	97	.....	
Do	....do	....do	....do	Saw	15	254	588	200	
Do	....do	....do	....do	Starch	2	21	22	.....	
Do	....do	....do	....do	Wheelwrighting	1	20	30	.....	
Do	... do	Vermont.....	Windham ...	Blacksmithing	1	7	6	.....	
Do	....do	....do	....do	Chairs	1	11	25	15	
Do	....do	....do	....do	Flouring and grist	6	121	186	.....	
Do	....do	....do	... do	Leather tanned and curried.	2	22	33	25	
Do	....do	....do	... do	Machinery	2	36	24	.....	

Table of utilized power on the Connecticut river and its tributaries—Continued.

Stream.	Tributary to what.	State.	County.	Kind of mill or manufacture.	Number of mills.	Total fall utilized.	Total water-power utilized.	Auxiliary steam-power.	Remarks.
						Feet.	*H. P.*	*H. P.*	
Minor tributaries..	Connecticut river.	Vermont.....	Windham	Needles and pins	1	17	40	.....	
Do.....	....do	....do	....do	Paper	3	77½	155	70	
Do.....	....do	....do	....do	Saw	8	137	205	65	
Do.....	....do	....do	....do	Screws	1	8½	10	.....	
Do.....	....do	....do	....do	Sewing-machines	1	17	40	.....	
Do	....do	....do	....do	Wheelwrighting.....	1	14	3	.....	
Do.....	....do	....do	....do	Wood turning and carving.	3	35	43	.....	
Do.....	....do	....do	Windsor.....	Agricultural implements .	1	4	18	.....	
Do.....	....do	....do	....do	Coffins, burial-cases, and undertakers' goods.	1	4	18	.....	
Do	....do	....do	....do	Cotton.....	1	27	250	220	
Do	....do	....do	....do	Flouring and grist	6	121	219	.....	
Do.....	....do	....do	....do	Iron castings	2	30	120	.....	
Do.....	....do	....do	....do	Machinery.....	1	17	25	.....	
Do.....	....do	....do	....do	Sashes, doors, and blinds..	2	54	100	75	
Do.....	....do	....do	....do	Saw	6	125	201	.....	
Do.....	....do	....do	....do	Tannery	1	20	30	.....	
Do.....	....do	....do	....do	Wheelwrighting.....	2	25	16	.....	
Do.....	....do	....do	Orange	Cutlery and edge-tools	1	.....	.....	.....	
Do.....	....do	....do	....do	Flouring and grist	2	37	90	.....	
Do.....	....do	....do	....do	Furniture.....	1	10	15	.....	
Do.....	....do	....do	....do	Saw	5	80	190	.....	
Do.....	....do	....do	Caledonia.....	Flouring and grist.....	2	31	175	.....	
Do.....	....do	....do	....do	Leather tanned and curried.	2	27	18	12	
Do.....	....do	....do	....do	Sashes, doors, and blinds ..	2	21	30	.....	
Do.....	....do	....do	....do	Saw	6	99	450	.....	
Do.....	....do	....do	....do	Starch	1	10	6	.....	
Do.....	....do	....do	....do	Wheelwrighting.....	3	49	33	.....	
Do.....	....do	....do	Essex	Saw	8	115	513	30	
Do.....	....do	....do	....do	Woolen.....	2	.....	18	.....	

Summary of power utilized on the

[With a few unimportant exceptions this table is based upon the returns of the census enumerators, and represents the power in use in 1880. The

	River.	COTTON-MILLS.			SILK-MILLS.			WOOLEN-MILLS. (a)			PAPER-MILLS.		
		Number of mills.	Water-power utilized.	Auxiliary steam-power.	Number of mills.	Water-power utilized.	Auxiliary steam-power.	Number of mills.	Water-power utilized.	Auxiliary steam-power.	Number of mills.	Water-power utilized.	Auxiliary steam-power.
			H. P.	*H. P.*		*H. P.*	*H. P.*		*H. P.*	*H. P.*		*H. P.*	*H. P.*
1	Connecticut river (main stream)	8	3,441	65	2	110	.....	6	1,213	.....	30	14,981	23
2	Salmon river and tributaries	13	683	85	1	.....	.....	.....	.....	.....	3	140+	.....
3	Hockanum river and tributaries	11	725+	525+	2	77	758	10	1,125	695	16	1,499	797
4	Farmington river and tributaries	3	1,270	100	1	100	.....	3	260	.....	10	1,259	60
5	Scantic river and tributaries	.....	.....	.....	.....	.....	.....	7	333	420	1	42	.....
6	Mill river (Hampden county, Massachusetts)	2	65	25	1	75	.....	1	60	.....	.....	.....	.....
7	Westfield river and tributaries	3	350+	.....	.....	.....	.....	3	118	120	13	1,978	650
8	Chicopee river and tributaries	23	7,610	1,390	.....	.....	.....	20	1,040	800	1	513	.....
9	Mill river (Hampshire county, Massachusetts)	2	185	125	3	100+	85	1	115	50	1	.....	.....
10	Deerfield river and tributaries	4	571	405	.....	.....	.....	1	50	40	.....	.....	.....
11	Miller's river and tributaries	4	187+	.....	1	30	.....	6	553	95	3	468	80
12	Ashuelot river and tributaries	4	.....	.....	.....	.....	.....	12	956	315	2	244	.....
13	Sugar river and tributaries	1	300	.....	.....	.....	.....	5	410	.....	3	255	50
14	Mascomy river and tributaries	.....	.....	.....	.....	.....	.....	1	.....	.....	1	50	33
15	Lower Ammonoosuc river and tributaries	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
16	John's river	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
17	Israel's river and tributaries	.....	.....	.....	.....	.....	.....	1	10	.....	1	25	.....
18	Upper Ammonoosuc river and tributaries	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
19	Mohawk river	.....	.....	.....	.....	.....	.....	1	12	.....	.....	.....	.....
20	West river and tributaries	.....	.....	.....	.....	.....	.....	1	20	.....	.....	.....	.....
21	Saxton's river	.....	.....	.....	.....	.....	.....	2	95	58	.....	.....	.....
22	Williams river and tributaries	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
23	Black river and tributaries	2	121	.....	.....	.....	.....	5	340	.....	.....	.....	.....
24	Ottaquechee river and tributaries	.....	.....	.....	.....	.....	.....	4	590	50	.....	.....	.....
25	White river and tributaries	.....	.....	.....	.....	.....	.....	3	67	.....	.....	.....	.....
26	Ompompanoosuc river	.....	.....	.....	.....	.....	.....	1	40	.....	.....	.....	.....
27	Wait's river and tributaries	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
28	Wells river and tributaries	.....	.....	.....	.....	.....	.....	1	20	.....	1	70	.....
29	Passumpsic river and tributaries	.....	.....	.....	.....	.....	.....	2	58	.....	2	1,090	.....
30	Nulhegan river and tributaries	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
31	Sundry small tributaries of Connecticut river	8	926	1,650	2	25	8	10	293	170	16	924	341
	Total, Connecticut river and all tributaries	88+	16,434+	4,370+	13	517+	851	107	8,378	2,753	104	23,538+	2,034

a Including also worsted-mills.

b Comprising blacksmithing shops, lock- and gun-smithing shops, brass and iron founderies, and establishments for the manufacture of agricultural implements, iron bolts and nuts, machinery, needles and pins, plated and britannia ware, pumps, saws, screws, scales and balances, sewing-machines and sewing-machine

c Comprising carpentering, cooperage, wheelwrighting, and wood turning and carving shops; planing-mills, and establishments for the manufacture of billiard carriages and sleds, coffins and undertakers' goods, excelsior, furniture, general house-furnishing goods, matches, models and patterns, picture-molding, piano

d Comprising bleaching and calendering, dyeing and cleaning, lithographing, marble and stone, calico printing, printing and publishing, soapstone, and wool and hose, boots and shoes, boot- and shoe-findings, bricks and tiles, brooms and brushes, buttons, carpet yarns, crashes, twines and bagging, cigars, cordage, drugs whetstones, hosiery, horse-blankets, kaolin and ground earths, leather board, linen, mattresses and spring beds, mosquito- and fly-nets, mucilage and paste, musical starch, stationery goods, tape, toys and games, upholstering materials, vinegar, whips and lashes, whip materials, wood-pulp, and wool extract.

e Power used mainly in the manufacture of wood-pulp.

NOTE.—In considering the results furnished by the above table, it should be borne in mind that while saw-mills stand first in number very small period, altogether, of the year. In reality, paper-mills far outrank all the other classes mentioned in the aggregate of water- Reckoning upon the same basis of working hours common among other mills, or, say, from ten to twelve hours, the total power utilized

Connecticut river and its tributaries.

aggregate has since been increased in a very considerable degree, as may be seen, for example, from the accounts of Holyoke and Bellows Falls.]

FLOURING- AND GRIST-MILLS.			SAW-MILLS.			VARIOUS METAL-WORKING ESTABLISHMENTS. (b)			VARIOUS WOOD-WORKING ESTABLISHMENTS. (c)			SUNDRY OTHER ESTABLISHMENTS. (d)			TOTAL.			
Number of mills.	Water-power utilized.	Auxiliary steam-power.	Number of mills.	Water-power utilized.	Auxiliary steam-power.	Number of mills.	Water-power utilized.	Auxiliary steam-power.	Number of mills.	Water-power utilized.	Auxiliary steam-power.	Number of mills.	Water-power utilized.	Auxiliary steam-power.	Number of mills.	Water-power utilized.	Auxiliary steam-power.	
	H. P.	*H. P.*		*H. P.*	*H. P.*		*H. P.*	*H. P.*		*H. P.*	*H. P.*		*H. P.*	*H. P.*		*H. P.*	*H. P.*	
5	373	.....	6	845	.....	22	1,628	170	6	110	.....	13	665	.....	98	23,366	258	1
4	71	.....	6	139	.....	10	154	40	5	245	30	.....	.....	.....	42	1,432	155	2
4	130	.....	4	95	.....	2	18	8	2	38	.....	3	135	6	54	3,842	2,720	3
15	432	8	53	1,429	.....	54	3,110	990	26	679	35	13	313	110	178	8,852	1,303	4
7	310	.....	6	125	.....	.....	.....	.....	.....	.....	.....	2	312	240	23	1,122	660	5
2	100	.....	.....	.....	.....	2	255	100	.....	.....	.....	.....	.....	.....	' 8	555	125	6
10	393	.....	29	771	65	13	226	5	26	504	8	33	380	.....	130	4,720	848	7
28	910	150	68	2,045	60	13	674	77	17	263	60	12	949	45	182	14,604	2,582	8
2	67	.....	1	33	.....	5	407	300	.....	.....	.....	6	154	95	21	1,061	655	9
20	528	.....	58	1,896	20	6	559	30	22	660	60	6	88	30	117	4,352	585	10
13	462	.....	58	2,194	80	17	662	57	76	2,863	810	10	153	6	188	7,572	1,128	11
5	158	.....	48	1,310	45	8	139	2	32	814	99	10	173	45	121	3,794	506	12
6	689	.....	26	836	.....	5	135	.....	15	367	.....	8	184	.....	69	3,176	50	13
7	320	.....	17	599	.....	6	120	.....	8	321	.....	8	166	.....	48	1,576	33	14
5	228	.....	18	890	.....	2	145	.....	11	343	40	9	920	.....	45	2,526	40	15
.....	.....	.....	2	150	310	.....	.....	.....	2	18	.....	.....	.....	.....	4	168	310	16
2	140	.....	14	661	40	1	20	.....	5	90	.....	2	28	.....	26	974	40	17
2	65	.....	10	480	150	1	3	.....	.....	.....	.....	.....	.....	.....	13	548	150	18
1	70	.....	2	60	.....	2	18	.....	5	33	23	5	40	.....	16	233	23	19
6	120	.....	44	1,370	118	.....	.....	.....	23	352	12	4	96	.....	78	1,967	130	20
4	148	.....	4	100	.....	.....	.....	.....	5	92	.....	3	145	8	18	580	66	21
4	181	.....	3	110	15	.....	.....	.....	4	40	.....	1	20	15	12	351	30	22
13	441	.....	18	646	.....	5	66	15	14	427	.....	5	91	.....	62	2,132	15	23
4	215	.....	11	501	.....	4	125	10	9	232	.....	2	60	25	34	1,723	85	24
18	846	.....	53	1,875	25	12	243	.....	18	509	.....	4	78	30	108	3,618	55	25
1	30	.....	7	245	.....	.....	.....	.....	2	40	25	2	50	.....	13	405	25	26
6	131	.....	13	341	.....	2	10+	.....	8	82	.....	1	32	.....	30	596	.....	27
4	108	.....	10	345	.....	1	.....	.....	1	25	.....	.....	.....	.....	18	628	.....	28
14	713	.....	37	1,348	.....	9	307	175	14	569	.....	7	e 2,840	.....	85	6,985	175	29
.....	.....	.....	1	240	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	240	.....	30
91	3,131	120	167	5,515	365	54	1,463	138	57	1,126	152	51	925	342	456	14,328	3,286	31
363	11,579	278	794	27,194	1,293	256	10,547+	2,117	413	10,842	1,354	220	8,997	997	2,298	118,026	16,047	

bells, bits and gimlets, brass-ware, bronze statuary, clocks, coffin-trimmings, cutlery and edge-tools, files, fire-arms, general hardware, hooks and eyes, iron forgings, materials, springs, steam fitting and heating apparatus, stencils and brands, swords, tin-, copper-, and sheet-iron ware, watch and clock materials, wire, and wirework. and bagatelle tables, cues, and materials, cigar- and packing- boxes, bobbins, carriages and wagons, carriage and wagon materials, chairs, chair-stock, children's materials, rules, sashes, doors and blinds, shoe-pegs, spools, washing-machines and clothes-wringers, wheelbarrows, wooden handles, and wooden ware.
grading and scouring works; tanneries, watch- and clock-repairing shops, and establishments for the manufacture of baskets, rattan- and willow-ware, leather belting and chemicals, emery-wheels, explosives and fireworks, fancy and paper boxes and other fancy articles, fertilizers, gloves and mittens, gunpowder, hones and instruments and materials, patent medicines and compounds, preserves and sauces, rubber and elastic goods, shoddy, soap and candles, spectacles, sporting goods,

and in the aggregate horse-power of wheels, a large proportion of them are not operated continuously, while many run during only a power actually employed, since, under ordinary circumstances, they are run day and night and continuously through the year. by paper-mills would probably correspond, in round numbers, to at least from 40,000 to 50,000 horse-power.

III.—THE QUINNIPIAC RIVER.

The Quinnipiac river has its source near the boundary line between the towns of New Britain and Farmington, Connecticut. Its entire length is about 35 miles. Most of the way it flows in a direction somewhat west of south, but in the lower part of the town of Southington it strikes southeasterly across a trap ridge which runs from the vicinity of New Haven northerly across the state; having crossed this ridge it resumes its former direction, and reaches Long Island sound through New Haven harbor.

The elevation of the track of the New Haven and Northampton railroad at the Quinnipiac crossing at Plantsville is 140.9 feet above mean low-tide at New Haven, indicating a probable average slope in the 25 miles from Plantsville crossing to the mouth of from 5 to 5½ feet per mile. The area drained by the Quinnipiac includes 156 square miles, and varies in width from 4 or 5 miles in the southern portion to about 13 miles in the latitude of Meriden. Although not large, the stream is regarded as well suited to manufacturing purposes. It is largely fed by springs and spring brooks which sustain its volume in the dry season.

The lower course lies through wide salt marshes, succeeded above Quinnipiac village by level meadows having a rather sandy soil. The valley is there broad and open, bordered by hills of moderate height. The first dam met in ascending the river is at Quinnipiac, a few miles from the mouth, and is a framed timber structure about 5½ feet high. The river-bed is there quicksand, and not only the dam but the masonry abutments rest on that foundation. Scour is prevented below the dam by loose stone, and in front of the west abutment by a plank apron. This abutment is 7 feet high, 9 feet wide at the base, 7 feet wide at the top, and is grouted throughout; it rises only slightly above the crest of the dam. The slope of the stream in its lower course being small, it readily chokes up during freshets, overflows the meadows and marshes, and rises so as to run smoothly over the top of the dam; it does not remain at a high stage, however, for more than a day or two. The fall at this dam is 6 feet. The only power in use is for a grist-mill and a small establishment manufacturing tire-bolts, blanks, and rivets. For the greater part of the year there is a moderate surplus power available for rent or lease. Mr. T. A. Todd, of Woodbridge, owns the privilege.

Estimate of power at Quinnipiac village.

Stage of river.	RAINFALL.					Drainage area.	Flow per second, average for the 24 hours.	Theoretical horse-power.		Effective horse-power utilized.
	Spring.	Summer.	Autumn.	Winter.	Year.			1 *foot fall.*	6 *feet fall.*	
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Sq. miles.*	*Cubic feet.*			
Low water, dry year	11	11	11½	11	44½	153	60	6.8	40	30±
Low water, average year							80	9.1	50	
Available 10 months, average year							100	11.4	70	

At Wallingford the stream is from 50 to 75 feet wide. The lower privilege at this point is owned and occupied by the R. Wallace & Sons Manufacturing Company, manufacturers of flat table-ware, and employing 275 hands. This company has 7 feet fall, and obtains 125 horse-power by water during about one half the year, but uses steam-power in addition. The dam is stone at the base, with timber above. The head- and tail-races, and especially the tail-race, are long, having a combined length of from one-half to three-quarters of a mile.

Above the privilege just described the Oneida community has a fine power, where it has until recently manufactured spoons. Several small buildings, mainly of wood, are standing on the property, but when visited, in October, 1882, they were not in use, and it was reported that the community was desirous of selling all its property here. The dam is a substantial structure of stone, about 10 feet high and from 180 to 185 feet long between abutments. The latter, together with a pier at the center of the dam, serve to support an iron bow-string bridge. This dam was built in 1872, at a cost, including roll-way, abutments, and supplementary embankment, of $30,000. The privilege has a fall of 9 feet, and is especially valuable from the fact that there is a large storage above the dam, the area of the pond being stated at 110 acres—ample for storing the night-flow of the stream in low stages.

Estimate of power at Community privilege, Wallingford.

Stage of river.	Drainage area.	Flow per second, average for the 24 hours.	Theoretical horse-power.	
	Sq. miles.	*Cubic feet.*	1 *foot fall.*	9 *feet fall.*
Low water, dry year	110	40	4.5	40
Low water, average year		60	6.8	60
Available 10 months, average year		70	8.0	70

NOTE.—This privilege is one-half or three-quarters of a mile from the New York, New Haven and Hartford railroad, and 12 miles by that line from New Haven. Owing to the large pondage the power can be doubled for 12 hours in the day during low stages of the river.

The first manufacturing point above Wallingford is Yalesville, 3 miles distant. There are three powers in use here. At the lowest, Messrs. G. I. Mix & Co. manufacture spoons and hollow-ware, employing 80 hands. They use 9 feet fall and 100 horse-power. The dam is about 5 feet high, built of stone in cement and resting upon a gravel and rock foundation. The river-bed in this section is mainly gravel, and underlying it and the surrounding country is red sandstone. The remainder of the fall at this privilege, above the height of the dam, is gained by long races, the combined length of the head- and tail-races being about half a mile. By means of embankments these are protected from freshet waters overflowing from the river, and in high stages the head is increased nearly as much in the head-race as it is diminished in the tail-race, so that but little trouble is experienced.

At the middle privilege the Charles Parker Company manufactures britannia spoons. The dam here is curving in plan, and is constructed of cut stone resting upon a red-sandstone foundation. A short race leads to the mill, where the head is 9 feet and the rated capacity of the wheels is 150 horse-power, which, it is stated, can always be realized.

The L'Homme Dieu Hardware Company, employing 50 hands in the manufacture of augers, is located on the upper Yalesville privilege, where it uses 8 feet fall and 130 horse-power. The dam rests upon ledge rock, is of cut-stone masonry, 40 feet long, about 9 feet high, and was built in 1845. The head- and tail-races are each in the neighborhood of 1,000 feet long.

The next power is at Hanover village, and is used by the Meriden Cutlery Company. The dam is an old structure, which was rebuilt some years ago and had an apron added at a total cost of $5,000. The roll-way is 150 feet long, 20 feet high, and has a bold curve up stream; it rests upon a rock bed, and consists of cut-stone masonry surmounted by five successive layers of 12-inch square timbers. The fall is 20 feet, and 150 horse-power of wheels is in use. This is the second privilege to be noticed having a large storage, the flowage being estimated at 90 acres with an average depth of 5 feet. The large pondage is a great benefit to the mills at Yalesville, where the ponds are comparatively small, and enables them to realize much more power than they otherwise would.

Passing farther up stream, the Quinnipiac is utilized at several points in the town of Southington, but being so far in the upper waters the powers obtained are small.

Only one record of a measurement of the discharge of the Quinnipiac was found; this measurement was made in the latter half of 1879 for the Connecticut state board of health,(*a*) and showed a flow of about 160 cubic feet per second below the Hanover dam, with the wheels running at the mill and water just dripping over the top of the dam. The drainage area above this point is 97 square miles.

Mill river, which lies immediately west of the Quinnipiac, supplies the city of New Haven with water, and its flow has been observed. As stated by the superintendent of the water-works, the minimum flow is 12,000,000 and the ordinary summer flow 20,000,000 gallons per day, or, respectively, 19 and 32 cubic feet per second. With the drainage area of 56 square miles, these figures correspond to a minimum of 0.34 and to an ordinary summer flow of 0.56 cubic foot per second to the square mile.

Table of utilized power on the Quinnipiac river and its tributaries.

Stream.	Tributary to what.	State.	County.	Kind of mill or manufacture.	Number of mills.	Total fall utilized.	Total water-power utilized.	Auxiliary steam-power.	Remarks.
						Feet.	*H. P.*	*H. P.*	
Quinnipiac river	Long Island sound	Connecticut	New Haven	Britannia and plated ware	3	25	375	125	
Do	do	do	do	Cutlery and edge-tools	1	20	150	.....	
Do	do	do	do	Augers	1	8	130	.....	
Do	do	do	do	Flouring and grist	1	6	15	.....	
Do	do	do	do	Iron bolts, etc	1		15	.....	
Do	do	do	do	Saw	1	.....	50	.....	Probably operated in connection with other works.
Do	do	do	Hartford	Cutlery and edge-tools	1	10	15	.....	
Do	do	do	do	Flouring and grist	1	8	75	.....	
Do	do	do	do	Hardware	3	33	109	50	
Do	do	do	do	Iron bolts, nuts, washers, and rivets.	1	5½	28	38	
Do	do	do	do	Saw	2	19	90	.....	
Tributaries	Quinnipiac river	do	New Haven	Agricultural implements	1	16	20	40	
Do	do	do	do	Brass and copper, rolled	1	24	400	(?)	
Do	do	do	do	Britannia and plated ware	1	10, 21	120	120	
Do	do	do	do	Carriage and wagon materials.	3	35	34	15	
Do	do	do	do	Cutlery and edge-tools	2	20+	62	80	
Do	do	do	do	Fire-arms	1	60, 80	160	480	
Do	do	do	do	Flouring and grist	2	19	78	.....	

a See page 59, report for year ending November 31, 1879.

Table of utilized power on the Quinnipiac river and its tributaries—Continued.

Stream.	Tributary to what.	State.	County.	Kind of mill or manufacture.	Number of mills.	Total fall utilized.	Total water-power utilized.	Auxiliary steam-power.	Remarks.
						Feet.	*H. P.*	*H. P.*	
Tributaries	Quinnipiac river	Connecticut	New Haven	Saw	3	64	54	.....	
Do	....do	....do	....do	Tools	1	13	13	.....	
Do	....do	....do	....do	Wooden handles	1	16	25	.....	
Do	....do	....do	Hartford	Buttons	1	5	6	.....	
Do	....do	....do	....do	Fancy articles	1	4½	8	.....	
Do	....do	....do	....do	Hardware	2	40	150	.....	
Do	....do	....do	....do	Iron bolts, nuts, washers, and rivets.	2	27	65	20	
Do	....do	....do	....do	Saw	1	24	23	.....	
Do	....do	....do	....do	Wood turning and carving	1	5	8	.....	

IV.—THE HOUSATONIC RIVER AND TRIBUTARIES.

THE HOUSATONIC RIVER.

This important stream is formed by small branches rising in the northern central part of Berkshire county, Massachusetts; it flows southerly through that county, passes down across Litchfield county, Connecticut, then constitutes the boundary between the counties of New Haven and Fairfield, and empties into Long Island sound 4 miles east of Bridgeport. The principal tributaries are the Naugatuck, Pomeraug, and Shepaug rivers, which join the main stream from the east in its lower course; numerous minor streams are also received, many of which are fed by large ponds and lakes. The Housatonic has a drainage area of 1,933 square miles, and a length by general course of about 110 miles; the actual distance from Pontoosuc lake, near Pittsfield, to the mouth, following the river closely, is at least 125 miles. Navigation extends to Birmingham, about 11 miles from the sound.

The fall of the river is large, amounting to nearly 1,000 feet from Pittsfield to the mouth; it is generally in the form of gravelly shoals, alternating with stretches of quiet water, but is occasionally interrupted by abrupt falls over rock, as at New Milford, Bull's Bridge, and Falls Village.

Table showing the fall in the Housatonic river.

Locality.	Distance above mouth.	Elevation above tide.	Fall between points.	Distance between points.	Average fall per mile between points.	Remarks.
	Miles.	*Feet.*	*Feet.*	*Miles.*	*Feet.*	
Pittsfield, Massachusetts	123	983				Elevation of water-surface, by Boston and Albany Railroad profile.
Ashley Falls, Massachusetts	81½	705	361	50.5	7.15	Elevation of rails at Housatonic Railroad crossing.
Falls Village, Connecticut	72½	622				Elevation of water-surface immediately below Housatonic Railroad Company's dam, as given in *Report of the Department of Public Works of New York City*, June 30, 1879. About 100 feet of the total fall of 165 feet occurs at Falls Village within a short distance.
			165	8.5	19.41	
1.8 mile above Cornwall Bridge	64	457				Elevation of water-surface as given in above report, page 71.
			352	34.5	10.20	
Mouth of Shepaug river	29½	105				Elevation of water-surface, as given by E. B. McNeill, civil engineer.
			105	18.5	5.68	
Birmingham	11	.....				Tide-water extends to Birmingham. As stated by Col. J. W. Barlow, corps of engineers, U. S. army, the mean rise and fall of tide at the mouth of the river (Stratford) is 5.2 feet, and at Derby 4.7 feet.

Measurements have several times been made of the volume of the river in low stages, with the following results:

During the development of the Birmingham power, measurements were carried on which served as a basis for the assumption still made, that the stream can be relied upon there in the lowest stage for an average discharge during the 24 hours of 500 cubic feet per second.

During the summer of 1878 the river was carefully examined in connection with a scheme for diverting its waters for the supply of the city of New York.(a) The flow was gauged at Kent by Mr. Horace Loomis, assistant engineer, from May 22 to November 1. The results showed a minimum flow, during the period of gaugings, of 260 cubic feet per second, average for the 24 hours; and a mean flow for the entire season (May 22–November 1) of 460 cubic feet per second, average for the 24 hours.

a See *Report of the Department of Public Works of New York City* for the quarter ending June 30, 1879.

During the years 1881–'82 occasional observations were made of the flow at New Milford Falls by Mr. B. H. Hull, civil engineer, of Bridgeport. These measurements were rather roughly made, with a view to finding the minimum flow available during working hours, and gave the minimum for the period stated of 916 cubic feet per second.

The results of these various gaugings may be thus presented:

Gaugings of the Housatonic river.

Locality.	Drainage area.	Flow per second.	Cubic feet per second per square mile.	Remarks.
	Sq. miles.	*Cubic feet.*		
Birmingham	1,562	500	0.32	Flow stated is the average for the 24 hours. Measurements made about 1867–'70, and result assumed as available amount of permanent water.
Kent	758	260	0.34	Minimum
Do	758	460	0.61	Mean for period May 22 to November 1. The volumes here stated are the average for the 24 hours. The measurements were made in the summer and fall of 1878 by Horace Loomis, assistant engineer of the board of public works, New York city.
New Milford Falls	1,068	916	0.86	Minimum flow during working hours, as roughly measured by B. H. Hull. Average flow for the 24 hours would be much less.

The Housatonic runs through a beautiful valley flanked much of the way by wooded hills, and with now and then a bordering of alluvial meadow-land. Its width increases from about 100 feet in the vicinity of Lee to 200 feet at Kent and to 500 or 600 feet at Birmingham. In the vicinity of Sheffield, in southern Berkshire county, the bed and banks are alluvial; at other points the material is gravelly, especially on the shoals, and at still others the stream falls over ledges of limestone and granite. Marble is quarried to some extent in the valley, and when free from flint is said to work well for building-purposes. A good quality of iron ore is found along the Housatonic, and is mined at Kent, Lime Rock, and in southern Massachusetts. Very pure quartz sand, suited to glass-making, also occurs.

The country drained by the river is quite thickly settled, the average number of inhabitants to the square mile, as stated by Mr. Henry Gannett, geographer of the Census Office, being 78, as against 57 for the Connecticut and 93 for the Merrimack basins. Especially in southwestern Connecticut and in western Massachusetts the varied and numerous manufacturing industries which have already been developed have attracted a large population of working people skilled in diverse pursuits—an important circumstance in connection with the further improvement of the Housatonic.

The valley has good railroad communications. The river is followed most of the way from the mouth to Pittsfield, in the upper waters, by the Housatonic railroad; it is crossed at the mouth by the New York, New Haven, and Hartford line, giving connections for New York and Boston; at Bennett's Bridge by the New York and New England railroad, running from Boston to Fishkill on the Hudson; at Shepaug by the Shepaug railroad; at North Canaan by the Hartford and Connecticut Western, reaching the Hudson river at Rhinebeck; and at Pittsfield by the Boston and Albany railroad. The distances by rail from tide-water, and from New York city, of some of the more important points along the river, are given below:

Distances by rail from tide-water of points on the Housatonic river.

Locality.	To Bridgeport.	To New York.
	Miles.	*Miles.*
Pittsfield, (*a*) Massachusetts	110	166
Stockbridge, Massachusetts	93	149
Falls Village, Connecticut	67	123
Cornwall Bridge, Connecticut	57	113
Bull's Bridge, (*b*) Connecticut	45	101
New Milford falls, Connecticut	32½	88½
Birmingham, Connecticut	(*c*)	69

a 51 miles from Albany. *b* Not now on railroad; would require a branch 2 or 3 miles long. *c* Located at head of tide-water in Housatonic.

Although a number of other interests are represented, especially at Birmingham, the great manufacturing industries of the main river are the production of paper and of woolen goods. Quite in contrast is the principal tributary, the Naugatuck, on which the chief use of power is in metal-working establishments. The development of power on the Housatonic has taken place mainly in the upper course, where the river is more easily and cheaply controlled than below, while numerous privileges available in the lower course have remained unimproved, or at least substantially so. Among the localities especially to be noticed in the latter respect are the interval of river between Birmingham and Bennett's Bridge, the falls at Bull's Bridge, and those at Falls Village.

Anchor-ice causes some hinderance to the mills on the upper river, though none of importance is experienced from floating cake-ice. Farther down stream, where there are fewer dams, surface-ice seems to be more troublesome, and the dam at West Cornwall is sometimes badly raked by it. On the Smith Paper Company's dams at Lee and Lenox, from 125 to 150 feet long, the common spring-freshet rise does not exceed about 5 feet; on the Ousatonic dam at Birmingham, with an overflow 636 feet long, the ordinary depth in a spring rise is estimated to be within the same limit. In 1874 a depth of 7 feet 9 inches on the dam was reached, and the next greatest depth observed was 6 feet 7 inches, in September, 1882. Freshets in the river run out quickly, and give rise to but little difficulty from backwater.

Judging by the results of gaugings, the yield of the Housatonic water-shed appears to be less per square mile, in very dry seasons, than in the case of either the Connecticut, Shetucket, or Quinebaug, to the eastward. Nevertheless, the volume is in general tolerably well sustained by a large number of ponds and reservoirs. It is almost impossible to obtain accurate data regarding these, but, using the best information at command, it is estimated that the total area of ponds and reservoirs within the Housatonic basin, making no account of the mill-ponds formed by the dams along the principal streams, amounts to at least 9,000 or 10,000 acres. Much has been done to improve the storage of the natural ponds by raising their surfaces by dams, and some entirely artificial reservoirs have also been built; undoubtedly the work might be carried on further on some of the tributaries, but it is the opinion of good judges that the reservoir capacity of the upper river has been developed about as much as is really practicable.

List of the principal ponds and reservoirs in the basin of the Housatonic river.

Name of pond.	Locality (town).	Tributary above what important point.	Approximate area.	Outlet.
			Acres.	
Pontoosuc lake	Lanesborough, Massachusetts	Pittsfield	a 313	Housatonic river.
Onota lake	Pittsfield, Massachusetts	do	555	Do.
Richmond pond	Richmond, Massachusetts	Lee	178	Scott brook, to Housatonic river.
Laurel lake	Lee, Massachusetts	do	152	Brook running to Housatonic river.
Plunkett reservoir	Hinsdale, Massachusetts	do	96	Artificial reservoirs draining through East branch to main Housatonic river. Areas are as given by manufacturers controlling them.
Tracy reservoir	do	do	65	
Ashmere reservoir	do	do	310	
Windsor reservoir	Windsor, Massachusetts	do	96	
Lake Mahkenac	Stockbridge, Massachusetts	Stockbridge	250	Brook running to Housatonic river.
Goose pond	Lee, Massachusetts	do	225	Do.
Greenwater pond	Becket, Massachusetts	do	100	Do.
Winchel pond	Egremont, Massachusetts	Sheffield	140	Green river, to Housatonic.
Six-mile pond	Monterey, Massachusetts	Falls Village	344	Mill river, to Konkapot, to Housatonic.
Brewer pond	do	do	250	Do.
Plantain pond	Mount Washington, Massachusetts.	do	120	Brook running to Housatonic.
Three-mile lake	Sheffield, Massachusetts	do	104	Iron Works river, to Housatonic.
East pond	New Marlborough, Massachusetts	do	104	Umpachina, to Konkapot, to Housatonic.
Washining lake	Salisbury, Connecticut	do	650	No outlet shown on map.
Washinee lake	do	do	400	Schenob brook, to Housatonic.
Wononscopomus lake	do	Cornwall Bridge	355	Brook running to Housatonic.
Lake in northwestern part	do	do	b 210	Do.
Do	do	do	b 225	Do.
Wanonpakok lake	do	New Milford	170	Brook running to Ten-Mile river, to Housatonic.
Mudge pond	Sharon, Connecticut	do	230	Do.
Spectacle ponds	Kent, Connecticut	do	245	West Aspetuck river, to Housatonic.
Waramaug lake	Warren and Washington, Connecticut.	do	745	Aspetuck river, to Housatonic.
Marshapeoge pond	Goshen, Connecticut	Bennett's Bridge	180	Shepaug river, to Housatonic.
Bantam lake	Litchfield and Morris, Connecticut.	Birmingham	c 1,070	Bantam river, to Shepaug, to Housatonic.
Long Meadow pond	Morris and Bethlehem, Connecticut.	do	255	Bantam and Pomeraug, to Housatonic.
Quaspaug pond	Middlebury and Woodbury, Connecticut.	do	535	Eight-Mile brook, to Housatonic.
North pond	Goshen, Connecticut	Mouth of Housatonic	d 300	Naugatuck river, to Housatonic.
Park pond	Winchester, Connecticut	do	d 60	Brook running to Naugatuck, to Housatonic.
Lily Brook reservoir	Wolcott and Waterbury, Connecticut.	do	e 112	Mad river, to Naugatuck, to Housatonic.
Chestnut Hill reservoir			e 80	Do.
Cedar Swamp reservoir			e 80	Do.
Approximate total area of 35 ponds and reservoirs			9,304	

a Area also stated by manufacturer on outlet at 575 acres.
b Extent of area lying within Connecticut. Lake is on boundary between that state and New York.
c Area also given as 1,200 acres.
d Area as stated by manufacturer interested in reservoir.
e Artificial reservoir; area as given by officer of reservoir association.

NOTE.—The above list includes the principal ponds and reservoirs drained by the river in Massachusetts and Connecticut, but the areas cannot be depended upon as very accurately stated. Unless otherwise indicated the areas for Massachusetts are as given by H. F. Walling in *Report of Massachusetts State Board of Health*, 1873, and those for Connecticut are as measured by planimeter on Clark and Tackabury's map of Connecticut, published in 1859.

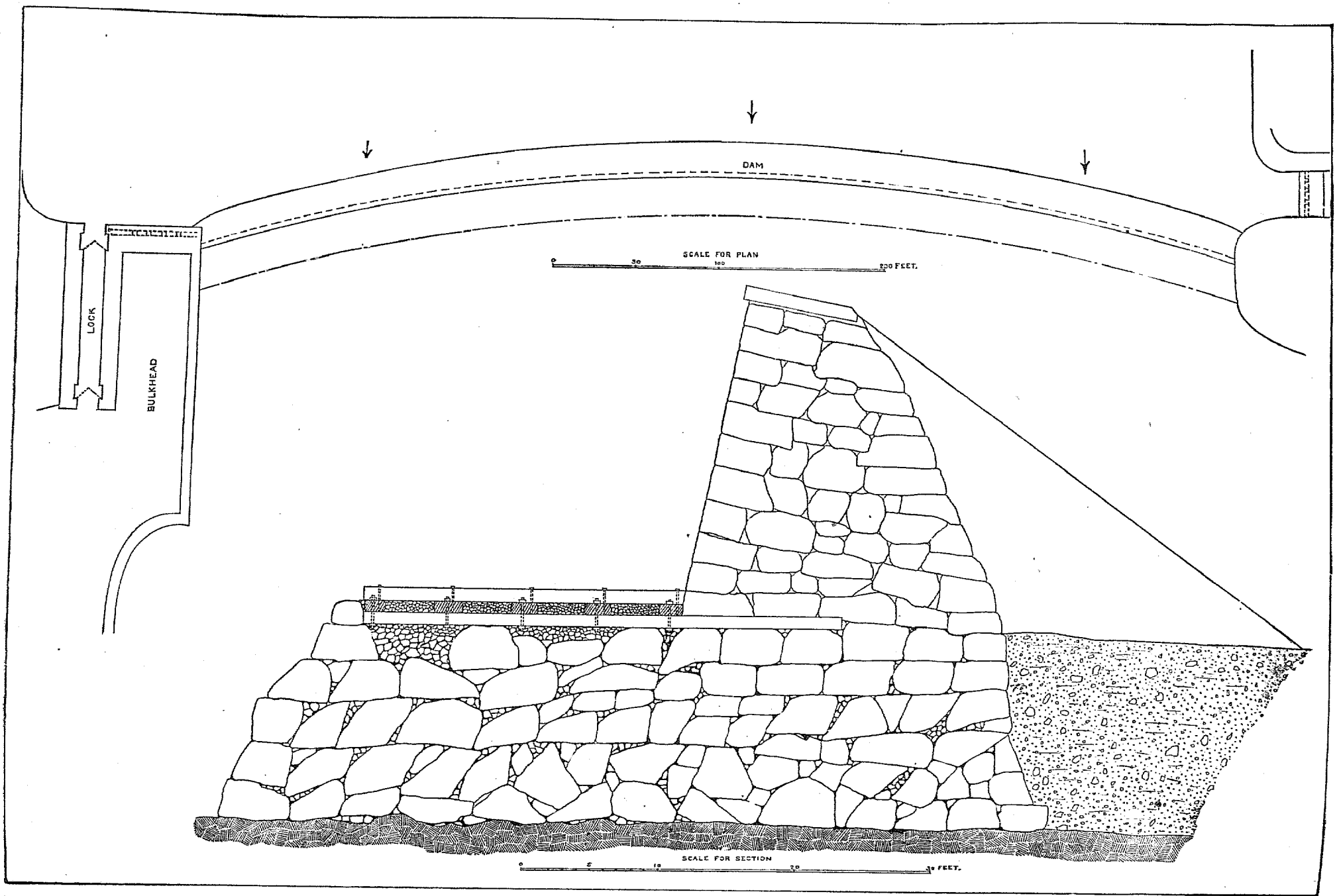

FIG. 29.—Plan and Section of Ousatonic Dam.

Power at Birmingham. (*a*)—The borough of Birmingham contains 3,000 inhabitants, and is located at the head of tide-water and navigation on the Housatonic, at the junction of that stream with its principal tributary, the Naugatuck. Vessels ascend the former river to the lower mills, and most of the heavy freighting is by water. At a reasonable expense it is stated that navigation can be extended up past half the length of the hydraulic canal. That canal is provided with a lift-lock from the river and a guard-lock to the pond above the dam, but passage through these is now confined to scows, which go a few miles up stream and bring down loads of timber, brick, and stone.

A plan of developing the water-power here was considered as long ago as 1838, and in the following year the state granted a charter for the purpose. Through fear of injuring the shad-fisheries, a high dam was not allowed, and the expense of bringing a long canal from a low dam was too great to be practicable, so that for many years nothing was done toward the actual improvement of the power. In 1864, however, permission was obtained to build a high dam; work was begun in July, 1867, and continued till October, 1870, when the dam was completed.

The privilege at Birmingham is unquestionably one of the best located and best developed in New England. It enjoys fine communications by land and water, and the natural site for canal and mills is excellent.

The dam is curving in plan, with a versed sine of 50 feet, and measures 636 feet in length between abutments. The width at base is 25 feet, the height from surface of apron to crest 22 feet, and the width of coping 8 feet. The structure is built of stone in cement, the face having a batter of about 2 inches in a foot. A timber apron, filled in with concrete, projects 24 feet from the front slope. The surface timbers of the apron are a foot square, and the bottom timbers extend some distance back under the stone-work of the dam. Where the latter rests upon gravel the apron has a pitch-plank, 7 feet long, supported at the end by a cross-timber 1 foot square. A row of sheet-piling extends under the down-stream edge of the apron and another under the face of the dam. The west abutment and the adjacent portion of the dam rest upon rock, while the remainder is founded upon gravel. In October, 1869, while the dam was in process of construction, and indeed nearly complete, a violent storm which swept over this part of the country caused a heavy freshet in the Housatonic; water poured 13 feet deep over the partially-finished dam, undermined and destroyed 160 feet of its length, and scoured out an immense cavity 20 feet deep in the river-bed immediately below. This space was afterward filled in with loose rock, the work on the dam was continued, and finally brought to an end in the following year.

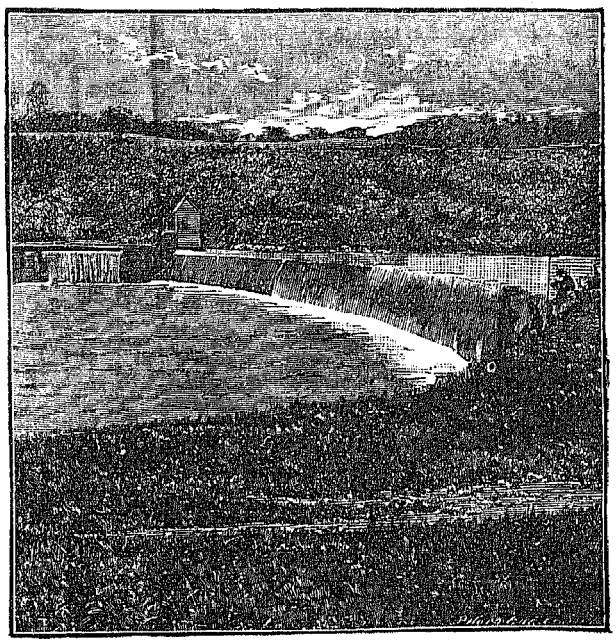

FIG. 28.—Ousatonic dam.

The abutments and bulkhead are also of masonry, in part coursed rubble and in part cut stone with rock face. The west bulkhead has 5 gate-openings, each 8 feet square; the east bulkhead has 3 gate-openings. The gates in the west bulkhead are operated by a turbine. Immediately adjacent the canal has a stone waste-weir 150 feet long. The dam sets back the water in the river some 5 miles up stream, thus affording a fine storage.

The west canal is 5,600 feet long, with a width at water-surface of 60 feet, and a depth below the same of 12 feet. For some distance from the dam it is restrained by an embankment on the river side; it then leaves the river somewhat and is carried partly as excavation along ground which has a gentle rise from the stream, leaving abundant and very favorable building-room between the two. The greater part of the way the canal is walled on both sides with dry stone. Nearly all the mills are upon the river side of the canal; one or two, however, are upon the opposite side and discharge tail-water into an arched passage-way running under the main canal. There is no other waste-weir than the one near the bulkhead, but a waste-gate in the lower course may be made to serve the same purpose, and gives opportunity for drawing off the water from the canal.

The cost of the works at Birmingham is stated as follows: Entire cost of dam, $264,000; locks, about $22,000; canal, $115,000; flowage and right of way, $17,000; an additional $12,000 for a break in the canal; making a total expenditure on account of hydraulic works of $430,000.

The concerns supplied with power are: 1. Wilkinson Brothers & Co., manufacturers of paper and wood-pulp; 2. Star Pin Company, hooks and eyes and hair-pins; 3. Spring Horse Shoe Company; 4. Wilcox & Howe, carriage hardware; 5. Robert Adams, cotton goods, mosquito-nettings, etc.; 6. D. M. Bassett, bolts; 7. Derby Silver Company, silver-plated flat and hollow ware; 8. Birmingham Corset Company; 9. Shelton Company, bolts and tacks; 10. Osborn & Cheesman Company, brass manufacturers; 11. Radcliffe Brothers, woolen goods; 12. E. C. Maltby, dippers and hollow ware; 13. Maltby, Stevens, & Curtis Company, flat plated ware; 14. New York Desiccating Company, desiccated cocoanuts; 15. A. B. Ruggles, toys.

a Mr. D. S. Brinsmade, secretary and treasurer of the Ousatonic Water Company, kindly furnished information concerning this power.

The Ousatonic Water Company owns the land and power, and leases the latter for terms of ninety-nine years. The usual policy of the company has been to donate the land for building-sites to desirable parties. The desire has been, not so much merely to lease all the power, as, for instance, to a few paper-mills, which use much water but do not employ a great many hands, as to secure a diversity of manufactures such as would serve to build up a large town.

The company does not guarantee water in any case, and if the flow of the stream should fall below the amount of permanent water leased, then all lessees of such water must share alike in a reduction. Three grades of water are recognized: First, permanent water, of which there are assumed to be 200 square feet (a square foot of water is declared in the leases to be 5 cubic feet per second, 12 hours in the day, 6 days in the week). As has before been mentioned, the flow of the river was gauged while the works at Birmingham were in progress, and the assumption here stated is based upon the results obtained at that time. The rental charged for permanent water is $250 per annum per square foot. Second, first surplus water, of which there are assumed to be 100 square feet. This can probably be relied upon for from ten to eleven months in the year, and is leased at the rate of $150 per annum per square foot. Third, second surplus water, of which also there are assumed to be 100 square feet, and which can be relied upon for much of the year, though the period varies considerably in different years. The rate for this class is $100 per annum per square foot.

Since land is commonly granted free at Birmingham, the rental charged there for water is a much better index of the real cost of the power to the manufacturer than at such a point as Holyoke, where the expenses for land and power are so combined as not to be easily separated. The Birmingham square foot, equal to 5 cubic feet of water per second, corresponds, under a fall of 22 feet, to almost exactly 12.5 theoretical horse-power. Assuming various degrees of efficiency in the turbines used, the equivalent effective powers, and their cost under the three classifications of water, are as follows:

Cost of water-power at Birmingham, on the Housatonic river.

Assumed efficiency of wheels.	Corresponding effective horse-power of 1 square foot of water.	COST PER EFFECTIVE HORSE-POWER.		
		Permanent water.	First surplus.	Second surplus.
60 per cent...	7.500	$33 33	$20 00	$13 33
65 per cent...	8.125	30 77	18 46	12 31
70 per cent...	8.750	28 57	17 14	11 43
75 per cent...	9.375	26 67	16 00	10 67
80 per cent...	10.000	25 00	15 00	10 00
85 per cent...	10.625	23 53	14 12	9 41

In case of a shortage of water the second surplus would be first curtailed, and then the first. If it became necessary to shut down on second surplus water, for instance, not all the lessees of that class of water would be equally curtailed at the same time, but in order as the water failed and according to the particular lease; generally speaking, the most recent lessee would be cut off first.

Up to October 13, 1882, 87½ square feet of permanent water had been leased and 14 square feet more had been contracted for; about one-half of the first surplus and 32 square feet of second surplus were also employed. About 183½ square feet of water will therefore soon be in use; but it is not to be inferred on that account that the available power is nearly exhausted, for that is not the case. The 183½ square feet include three grades of water, and from the company's stand-point the privilege is only about one-half disposed of, since there has been sold only one-half the permanent water. It is desired to sell the remaining half, and as it shall become necessary in pursuing that plan surplus water will be cut off so that the full amount of permanent water may be furnished to the lessees. The paper-mills are almost the only users of surplus water, and so long as the power has been but partially developed it has been for their interest to depend largely upon that class, which is much cheaper than permanent water.

The total amount of power in use here in the fall of 1882 was stated at about 1,500 horse-power by day and 500 by night. During the very dry summer of that year it became necessary to cut down slightly on surplus water, but it is claimed that with 2 feet of flash-boards on the dam there would have been no shortage. Flash-boards have not hitherto been employed, but the company purposes to use them in the future, if necessary. Except from August 21 to October 3 in the season alluded to, water wasted over the dam during the day—in other words, continuously; and in that interval it was with few exceptions running over in the morning, though not during the day. The pond is never drawn down more than 6 inches below the crest of the dam, the company having the right to curtail the use of water whenever that limit shall have been reached. There having been usually thus far an abundant supply, a very close watch has not been maintained upon the amounts of water in use. Whenever considered desirable, measurements have been made, always employing Francis' methods, with the use of either floats or weirs.

The fall from the water-surface in the canal at the mills, assumed to be at the same level as the crest of the dam, to average tide-water in the river is 22 feet. The fall varies slightly along the canal, but not to exceed 1 foot. It also fluctuates a little with the tide, the average rise and fall of which opposite the canal is given as from 2 to 3

feet. The duration of high-tide here, however, is said to be much shorter than at the mouth of the river. During freshets there is, of course, backwater in the river, but it lasts not more than a day or two so as to be a serious hinderance, the river quickly running out. Observation has shown that for every foot of rise on the dam there is a rise of about 2 feet in the river along the line of the canal. As before mentioned, the usual spring-freshet depth on the dam is not over 5 feet, and since its completion the depth has not exceeded 7 feet 9 inches.

The building of mills can be continued on either side of the river. The west canal will not be extended any farther, but not much over one-half the sites along its course are yet occupied. At any time when a demand for sites on the east side shall arise, the water-power company is prepared to use the canal on that side, which is already built and walled and connected with the pond by a substantial bulkhead with gates. This canal is designed to have a length of 1,500 feet, and will afford good building-sites along its entire course.

The available power at this privilege may be estimated as follows:

Estimated power of the Housatonic river at Birmingham.

Stage of river.	Rainfall on basin.					Drainage area.	Flow per second, average for the 24 hours.	Theoretical horse-power.		Effective horse-power utilized.
	Spring.	Summer.	Autumn.	Winter.	Year.					
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Sq. miles.*	*Cubic feet.*	*1 foot fall.*	*22 feet fall.*	
Low water, dry year	11	13½	13½	10	48	1,562	550	62.5	1,375	In the fall of 1882 stated at about 1,500 by day and 500 by night.
Low water, average year							690	78.4	1,725	
Available 10 months, average year							900	109.1	2,400	

The river above Birmingham.—From Birmingham backwater to Bennett's Bridge the Housatonic is almost a continuous rapid, with only short stretches of smooth water. The bed is gravelly, and the banks are firm and of good height, with no meadow-land until within half a mile or so of the bridge. This section of the stream is at present without railroad facilities, though a line is projected to follow up the west bank. It is considered that two good privileges might be developed here, with a fall of 15 or 20 feet each. According to the elevations previously given there is a fall of about 83 feet from the mouth of the Shepaug to the top of the Ousatonic dam, a distance of say 17 miles; what amount of this fall is actually available for power can be determined only by careful examination. There would be little difficulty in finding good sites for dams, but this part of the valley has the objection of being rather narrow and not favorable to the location of large villages.

At Bennett's Bridge an island divides the stream into two channels, one 180 and one 75 feet wide. For perhaps 2 miles above this point the stream is almost free from rapids, there being but one or two short ones. The valley is more open than below, the banks are frequently sandy, and are succeeded away from the stream by narrow meadows. Still farther up stream shoals become more frequent, but the banks are yet sandy in places, though generally of good height.

At Little York, a settlement of a few houses about 1 mile below Shepaug, a rude obstruction of stones has been thrown across the river, and turns water into a race a few hundred feet long. A small power is used here for a saw-mill and a cider-mill.

At Southville (Hawley's Bridge) there still remains part of a low dam, where power was used to some extent a number of years ago.

At Lanesville (New Milford Falls), about 26 miles by river above Birmingham, a fine power has been developed by the Bridgeport Wood Finishing Company. With the exception of a short piece next the west bank the dam is entirely a natural ledge of slaty rock. A large amount of rock excavation has been done, both for the wheels and on the site of the mill. Operations were begun in the summer or fall of 1881, and in the succeeding year 400 or 500 pounds of dynamite were used for blasting. The wheel-pit is sunk 20 feet into solid rock, and the head-race is cut out into the river sufficiently to thoroughly divert the low-water flow to the wheels. The fall obtained is 12 feet, and power is to be taken from two turbines, each of 250 horse-power. The works of the company, hitherto maintained at Fort Ann, New York, are to be removed to this point. Silica is conveniently obtained at various localities within a few miles of the mill, and will there be ground up into a very fine powder employed in giving a fine finish to wood and for other purposes. It is largely used by the Wheeler & Wilson Sewing Machine Company.

This privilege is located at the head of a narrow gorge, through which the stream tumbles down with rapid fall. There is no opportunity, however, for utilizing this larger descent by any ordinary means, either in the gorge or for some distance below; in the narrows the stream is entirely out of reach, and upon issuing from them it immediately spreads out into a wide and long pool.

Above this point the valley assumes an entirely new appearance; the hills recede on either hand and inclose fine level meadows; the stream is now quite free from shoals, and runs smoothly between alluvial banks of sandy loam.

Between the falls and New Milford village, and about a mile below the latter, James A. Giddings, jr., uses 150 horse-power for a grist-mill. He has a fall of 7 feet, which he states can be increased to 10 feet.

Estimate of power at Giddings' mill.

Stage of river.	Drainage area.	Flow per second, average for the 24 hours.	Theoretical horse-power.			Effective horse-power utilized.
	Sq. miles.	*Cubic feet.*	1 *foot fall.*	7 *feet fall.*	10 *feet fall.*	
Low water, dry year	1,068	380	43.2	300	430	150
Low water, average year		480	54.5	380	540	
Available 10 months, average year		670	76.1	530	760	

At Gaylordsville, a small village 2½ miles south of South Kent, rapids extend along the stream for 600 or 800 feet. The river is 150 or 175 feet wide; the banks are of good height, and on the west side, below the highway bridge, there is a convenient flat for building. The privilege seems to be a good one, and was formerly used by a grist- and saw-mill.

At Bull's Bridge, about 2 miles west of South Kent, there is a large undeveloped power. It is not upon any railroad, but it is said that a spur of 2 or 3 miles, to connect it with the Housatonic line, could be built without difficulty. There is a collection of a few houses near by, but no village of consequence. The falls here were probably once nearly or quite continuous, but a dam formerly in use sets back the river so as to cause slack-water for a little distance, and divides the falls into what may be called the upper and lower.

At the head of the lower falls is the old dam, a log structure, now broken and in poor condition. Rapids extend several hundred feet down stream, and the pocket-level indicates a fall of 16 or 18 feet from the crest of the dam to their foot. The banks are steep and rocky on each side. Twelve feet fall was once used here at an iron furnace on the left bank a couple of hundred feet below the dam. Water was conveyed in a wooden flume laid in an open way, inclosed on one side by the rocky bank and on the other by a dry-stone wall; both flume and wall are partly in ruins. This lower privilege is said to be owned by John Bogart, esq., of Lee, Massachusetts.

The upper falls are but a short distance above the dam. They are apparently about 400 feet in length, with a descent, as shown by the pocket-level, of say 22 feet. At an ordinary stage the river-bed displays a great mass of granite, down which the stream rushes in a channel-way perhaps 50 or 75 feet wide, though from one high bank to the other the width is much greater. Here, as at the lower falls, the banks are steep and rocky.

The entire fall at Bull's Bridge from the head of the upper falls to the foot of the lower privilege is probably about 40 feet, and this might be considerably increased artificially by a dam at the head. The site for such a structure is good, the ledges in the stream almost forming a natural dam. In the examinations made in 1878 to determine the practicability of drawing upon the Housatonic river for the water-supply of New York city, the privilege at Bull's Bridge was considered among the various points available for the purpose; but on account of the expense which the selection of this site would involve in pumping water to a height of over 100 feet in order to convey it over into the Croton valley, it was rejected. On page 72 of the report previously mentioned by title, the fall available at Bull's Bridge is referred to as 45 feet, though the height of dam necessary to give that fall is not stated. The entire fall here might be combined in one privilege or divided into two powers. In any case considerable blasting would be found necessary and the expense of improvement would be large. The adjoining land on either side of the river is hilly, but offers a fair location for mills on the right bank.

Estimate of power at Bull's Bridge.

Stage of river.	RAINFALL ON BASIN.					Drainage area.	Flow per second, average for the 24 hours.	Theoretical horse-power.				
	Spring.	Summer.	Autumn.	Winter.	Year.							
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Sq. miles.*	*Cubic feet.*	1 *foot fall.*	12 *feet fall.*	40 *feet fall.*	45 *feet fall.*	50 *feet fall.*
Low water, dry year	10½	13½	14½	10	48½	*a*792	280	31.81	380	1,270	1,430	1,590
Low water, average year							350	39.76	480	1,590	1,790	1,990
Available 10 months, average year							490	55.66	670	2,230	2,500	2,780

a Above Ten-Mile river.

It may be said in general of the interval between New Milford and Kent, that the stream has a gravelly bed with banks usually firm and of good height. There is a succession of shoals and long stretches of smooth water, and numerous sites are to be found where a dam could be built to good advantage. The valley is of moderate width, and is succeeded by a hilly country tolerably well wooded with a young growth. The larger timber has been mainly cut away to supply charcoal to the iron furnaces, and in many places the hills are quite bare.

About half a mile above the village of Kent the Kent Iron Company has a furnace giving employment to 20 men. A log dam resting partly upon rock and partly upon gravel crosses the river in an irregular line. Water is conveyed 200 or 300 feet in a race and a wooden flume, and power is used for two blowers, a pump, and a 4-run grist-mill; 8 feet fall and perhaps 90 horse-power are in use, with surplus water at all times.

From Kent to Cornwall Bridge, about 8 miles, the general features of the river remain substantially unchanged. At Swift's Bridge a mile or more below Cornwall Bridge, power was formerly used for over 20 years by a grist-mill. The dam was *located half a mile up stream and water brought down the right bank in a race, which remains* in good condition, except that it is overgrown with brush. At the site of the old dam the river is 200 feet or more in width, and is said to have a bed of solid rock most of the way across. The structure was built of logs with stone abutments, but has entirely gone to ruin, only a few logs and scattered stones remaining. At the foot of the race a fall of 12 or 15 feet is available. The privilege is owned by Mr. Edward Bierce, of Cornwall Bridge.

Estimate of power at Swift's Bridge.

Stage of river.	Drainage area.	Flow per second, average for the 24 hours.	Theoretical horse-power.		
	Sq. miles.	*Cubic feet.*	1 *foot fall.*	12 *feet fall.*	15 *feet fall.*
Low water, dry year	735	260	29.5	350	440
Low water, average year		330	37.5	450	560
Available 10 months, average year		460	52.3	630	780

Just above the railroad station at Cornwall Bridge another privilege was formerly occupied by a grist-mill, but all signs of the improvements have vanished. There is a good site for a dam, with rock bottom two-thirds of the way across and gravel the remainder. The Housatonic railroad skirts the bank a short distance above the rapids, at an elevation of 11 or 12 feet from low water. On account of danger of flooding the tracks in high water it would not answer to build a dam more than a few feet high, unless it were given an unusually long overflow. With a dam as high as 6 or 7 feet and a race 300 feet long, from 10 to 12 feet fall could be made available. Mr. Benjamin F. Bierce, of Cornwall Bridge, owns this privilege, including right of flowage and right of way for a canal 300 feet long. The power is a good one, and has the advantage of a very convenient building-site.

Estimate of power at Cornwall Bridge.

Stage of river.	Drainage area.	Flow per second, average for the 24 hours.	Theoretical horse-power.		
	Sq. miles.	*Cubic feet.*	1 *foot fall.*	10 *feet fall.*	12 *feet fall.*
Low water, dry year	724	260	29.5	290	350
Low water, average year		320	36.4	360	440
Available 10 months, average year		450	51.1	510	610

There is no power in use above Cornwall Bridge until we reach West Cornwall, where Messrs. Mallinson and Wood own 13 feet fall. The privilege is improved by a log crib-work dam filled in with stone; the dam averages *about 8 feet in height, and has a sloping face, with an apron covered with 3-inch planking.* The race is several hundred feet long, from 12 to 14 feet wide, and from 6 to 8 feet deep. Joseph Mallinson uses power for the manufacture of shears and scissors and for a grist-mill, and rents some power to a foundery. He has a 60 horse-power wheel, but does not use more than two-thirds of its power.

The next power to be noticed is at Falls Village, where there is a greater concentrated fall than is to be found upon any other stream of equal size tributary to Long Island sound. The Housatonic there falls abruptly over limestone ledges, and has a total descent of over 100 feet in a short distance. A little way above the head of the falls the Housatonic Railroad Company uses about 180 horse-power and from 11 to 13 feet fall in its shops, its privilege being improved by a dam.

The main privilege embraces a fall, as nearly as could be ascertained, of 95 feet,(*a*) and was partially developed about the year 1850 by the Falls Village Water Power Company. From the head of the falls a canal was carried approximately half a mile, with a width of 35 feet and a depth of 6 or 8 feet. It runs close by the railroad track, *on a side-hill, its outer bank being supported by a fine masonry retaining-wall. At the end of this upper level is* a bulkhead, through which water may escape down a steeply-inclined channel paved with stone and cement to the second or middle level, which is perhaps a quarter of a mile long and of the same cross-section as the upper level. From the second canal there is an escape to the third level. On the course of the latter was designed, in a natural depression, a large reservoir, from at least two points of which water was to be carried off in canals for use. After extending these canals for a short distance from the reservoir, work ceased. It is said that a stop was put to operations by dissensions in the company, and a magnificent power has continued to remain idle. It certainly seems a great misfortune that private disagreements should have prevented the full development and use of so fine a privilege. It would be an easy matter to divert water into the upper level, a low dam running

a See page 76, *Report of the Department of Public Works of New York City* for the quarter ending June 30, 1879.

across on a ledge being sufficient for the purpose. It is said that this upper canal leaked more or less when filled. It appears to be in good condition, but the bulkheads on this and the second level were constructed of large blocks of stone supported by timber, and would need to be rebuilt for use, the timber having decayed.

Estimate of undeveloped power at Falls Village.

Stage of river.	Rainfall on basin.					Drainage area.	Flow per second, average for the 24 hours.	Theoretical horse-power.	
	Spring.	Summer.	Autumn.	Winter.	Year.				
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Sq. miles.*	*Cubic feet.*	*1 foot fall.*	*95 feet fall.*
Low water, dry year	10½	13⅛	14½	10	48⅓	644	250	28.40	2,700
Low water, average year							310	35.22	3,350
Available 10 months, average year							420	47.71	4,530

Above Falls Village the stream becomes more flat, and continues so through the town of Sheffield, in Massachusetts. At Great Barrington we strike upon the principal manufacturing portion of the Housatonic valley, and thence to the extreme head-waters there is a quick succession of busy little villages, the most important productions in which are paper and woolen goods. On the east branch, in the town of Dalton, George T. Plunkett, esq., of Hinsdale, owns 100 feet of unimproved fall; but on the main river between Falls Village and Pittsfield only one available unoccupied fall was reported, though it is possible there is some other fall entirely unimproved. The privilege referred to is owned by Captain Seeley, of Housatonic, and is the one formerly occupied by the Stockbridge Iron Works. The available head is 23 feet, the power corresponding to which may be estimated as follows:

Estimate of power at the Stockbridge Iron Works privilege.

Stage of river.	Rainfall on basin.					Drainage area.	Flow per second, average for the 24 hours.	Theoretical horse-power.	
	Spring.	Summer.	Autumn.	Winter.	Year.				
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Sq. miles.*	*Cubic feet.*	*1 foot fall.*	*23 feet fall.*
Low water, dry year	12	14	16	10	52	284	130	14.8	340
Low water, average year							160	18.2	420
Available 10 months, average year							210	23.9	550

In the following table are given a list of the principal water-privileges on the Housatonic river below Pittsfield, and a summary of power available at the various unimproved falls, so far as could be learned of them. It is not to be supposed that all the available fall is here accounted for. But few reliable elevations on the river could be obtained from which to determine the intervening fall, and there are some portions of its course in which the descent is comparatively uniform, and where the head to be obtained is mainly determined by the height of dam. In some such cases estimates of power are given corresponding to one foot of fall:

Principal water-privileges on the Housatonic river below Pittsfield.

Locality.	Drainage area.	Firm.	Manufacture.	Fall.	Estimated theoretical horse power. (a)			Remarks.
					Low water, dry year.	Low water, average year.	Available 10 months, average year.	
	Square miles.			*Feet.*				
Lenox		Smith Paper Company	Paper	10				The various privileges owned by the Smith Paper Company are improved by wooden dams built at various times in the past sixty years, and ranging from say 125 to 150 feet in length and from 4 to 15 feet in height. The aggregate horse-power of wheels at all the privileges was stated in 1880 to be about 1,480.
Do		do	do	10				
Lee		do	do	12				
Do		do	do	15				
Do		do	do	10				
Do		do	do	9				
South Lee		Hurlbut Paper Company.	do	19				Stone dam, built in 1873, cost $6,000; from 300 to 400 horse-power of water used.
Stockbridge	284	Privilege owned by Captain Seeley, of Housatonic.	Unoccupied	23	340	420	550	Formerly occupied by the Stockbridge Iron Works.
Glendale		Chapin & Callender	Paper (?)	20				Use 200 horse-power, and can run at full capacity throughout the year. Have large surplus power.
Do		Adams Mill	Woolen goods	10				300 horse-power used.

a Based upon average flow for the 24 hours.

Principal water-privileges on the Housatonic river below Pittsfield—Continued.

Locality.	Drainage area.	Firm.	Manufacture.	Fall.	Estimated theoretical horse-power.(a)			Remarks.
					Low water, dry year.	Low water, average year.	Available 10 months, average year	
	Square miles.			*Feet.*				
Housatonic		Monument Mills	Cotton goods	10				176 horse-power used. Old dam built in 1760, 144 feet long, 16 feet high.
Do		do	do	8–10				88 horse-power used.
Do		Owen Paper Company	Paper	15				80 horse-power used.
Great Barrington		Berkshire Woolen Company.	Woolen goods	11				250 horse-power of wheels in 1880.
Falls Village		Housatonic Railroad Company.	Power used at shops.	11–13				180 horse-power of wheels in 1880.
Do	644	Privilege partially developed by Falls Village Water Power Company.	Unoccupied	95	2,700	3,350	4,530	A splendid power.
West Cornwall		Jos. Mallinson	Shears and scissors. Power also used for grist-mill and foundery.	13				Not over 40 horse-power used.
Cornwall Bridge	724	Privilege owned by Benjamin F. Bierce.	Unimproved	10–12	290–350	360–440	510–610	Good building-site in village close by railroad.
Swift's Bridge	735	Privilege owned by Edward Bierce, of Cornwall Bridge.	... do	12–15	350–440	450–560	630–780	Formerly used for twenty years by grist-mill. Good site for dam. Old race remains.
Kent		Kent Iron Company	Power used for furnace and grist-mill.	8				Perhaps 90 horse-power in use.
Bull's Bridge	792	Said to be owned in part by John Bogart, of Lee, Massachusetts.	Unimproved	40–50	1,270–1,590	1,590–1,990	2,230–2,780	Fine privilege; 12 feet fall formerly used by iron works.
Gaylordsville	971	Privilege owned by various parties.	do	10	300	490	680	10 feet fall said to be available. Dam would need to be 230 feet long.
One mile below New Milford.	1,068	J. A. Giddings, jr.	Power used for grist-mill.	7–10	300–430	380–540	530–760	Owner would sell at satisfactory price. About 150 horse-power used.
Lanesville (New Milford Falls).		Bridgeport Wood Finishing Company.	Grinds silica	12				Power recently developed. 500 horse-power to be used.
Southville	1,202		Unimproved		b48.8	b60.2	b85.2	Power formerly used.
Little York	1,371		Small power used for saw-mill and cider-mill.		b54.5	b68.2	b96.6	Small settlement.
Bennett's Bridge to Birmingham.	1,496–1,562		Unimproved		b60	b75	b105	Estimated that two good powers can be developed with from 15 to 20 feet fall each.
Birmingham	1,562	Power owned by Ousatonic Water Company.	See description	22	1,375	1,725	2,400	Located at tide-water.

a Based upon average flow for the 24 hours. b Per foot fall.

TRIBUTARIES OF THE HOUSATONIC RIVER.

THE NAUGATUCK RIVER.

This is the largest tributary of the Housatonic, and has a drainage area of 313 square miles. It heads in the towns of Goshen and Norfolk, Litchfield county, Connecticut, runs southerly and joins the main river on the east side at Birmingham, having a length by general course of about 35 miles. It is followed closely from the mouth to Wolcottville, well up toward the head-waters, by the Naugatuck railroad, and is crossed at Waterbury by the main line of the New York and New England railroad. From the best information to be obtained the fall from Waterbury to mean tide at Birmingham, a distance of about 18 miles by river, appears to be something over 230 feet,(a) or an average of about 13 feet per mile.

The Naugatuck was examined from the mouth to Waterbury. It can have but moderate value for power above that point; in fact, it is there joined by Mad river, which is regarded as more important than the main stream above their junction, although its drainage area is much smaller. This probable disparity in value is due to the two facts that Mad river has a more rapid fall than the Naugatuck and that it is better sustained in the dry season. Both streams are moderately supplied with storage reservoirs. The former has three principal reservoirs controlled by the Mad River Water Power Company: Lily Brook reservoir, of 112 acres; Chestnut Hill reservoir, 80 acres, and Cedar Swamp reservoir, 80 acres. On the upper waters of the Naugatuck are North pond, in Goshen, said to contain from 300 to 350 acres, from which about 6 feet can be drawn, and Park pond, in Winchester, of 60 acres, from which an average of 10 feet can be drawn. The subject of further reservoiring the stream has been

a Mr. W. G. Smith, formerly resident engineer of the New York and New England railroad, gives the elevation of the Naugatuck river at Waterbury as 242 feet above low water in Boston harbor.

discussed, but no action has yet been taken. It is said that there are no natural ponds or marshes of large size which could be improved for storage, and it is the opinion of prominent manufacturers that the expense of reservoirs under the circumstances would be out of proportion to the benefits to be derived.

Throughout the section examined the river has a gravelly bed, over which it runs in shoals and rapids, except where interrupted by slack-water from the dams. The valley is narrow and inclosed by high hills, which are in many places rocky, steep, and even precipitous. So far as was noticed one bank or the other of the stream is usually low. The character of the country drained is such that the river is rapid in rise and fall and its freshets are heavy. At Seymour it is said to continue rising about 6 hours after a rain has ceased, and then to begin receding. In the heavy storm of September, 1882, it rose at the rate of about a foot an hour, and fell away again with nearly the same rapidity.

The dams on the Naugatuck are nearly all low structures, the falls in use being largely gained by long races; they are mostly old, and no other explanation of their having been built low was received than that the river is one requiring strong works, and high dams would have been more expensive. It would appear also that, from the common occurrence of a low bank for some distance back on one side or the other, higher dams would also have to be considerably longer than the present ones, and would be more costly on that account. The powers on this river were generally developed years ago, when the concerns using them were small; the latter have increased greatly in size, have in many cases outgrown the stream, and have been obliged to add steam-power. The use of long races increases the danger of trouble from ice, and it was said by an engineer well acquainted with the river, that they are in many instances too small to carry the required volume of water, so that when the wheels are being run at full capacity they are liable to be drawn down and the working head becomes reduced.

The first water-privilege above the mouth of the river is owned by the Birmingham Water Power Company. The dam is a rough timber structure, 7 feet high and perhaps 300 feet long. It extends in two rather irregular sections from either shore to an island in the center of the river. The only abutments are piles of loose bowlders. From the foot of the dam extends an apron of short lengths of logs, below which the river-bed is still further protected by a mass of loose stone. The dam is located in the lower part of the borough of Ansonia. Two races, soon uniting in a single line, convey water a little over a mile down the west bank to Birmingham, where power is used by the following principal concerns:

The Sterling Organ Company, manufacturer of cabinet organs; the Birmingham Bit Company; the Birmingham Iron Foundery; the Peck, Stowe, & Wilcox Company, rolling-mill and bolts; the Howe Pin Company; Summers & Lewis, furniture; H. S. Sawyer, feed-mill; R. M. Bassett, corset supplies; H. & C. B. Alling, woolen-mill.

The fall at the mills is about 12 feet, subject to some fluctuation from tide-water, which sets up to this privilege. The permanent flow of the river is assumed at 20 square feet, which is all leased, as well as 20 square feet of surplus water. According to the census enumerators' returns, the aggregate horse-power of wheels employed on the privilege in 1880 was 590. Water is regarded here as the principal power, although resort is made to steam for additional power in low water. The amount, 20 square feet, assumed as the permanent flow of the stream is said to be somewhat above the real low-water volume, and for from one to three weeks in the year is not realized.

The square foot, to which reference has been made, and the method of measuring it, are thus defined in the leases:

> And the Birmingham standard square foot of water hereby leased shall consist of 144 square inches of aperture, and such aperture shall be of a parallelogram form, and situated in the tail-race conducting the water herein granted from the water-wheel where used, and the water drawn through said aperture under a head of 12 inches from the surface of the water to a line supposed to be drawn longitudinally through the middle of said aperture shall constitute the Birmingham standard square foot of water.
>
> And the said one Birmingham standard square foot of surplus water hereby leased and the water drawn and used from said reservoir and canal by said ——, party of the second part, under other deeds or leases shall be measured in the manner following; to wit, a flume or trough shall be constructed in the tail-race through which the water used by said ——, party of the second part, shall be discharged, equal in width to the number of square feet of water that the said —— or his assigns is or shall be entitled to draw from said reservoir or canal under a head of one foot, with vertical plank sides at least 18 inches in height and a smooth plank bottom, inclined in the direction of the descent of the tail-race at the rate of 1 inch in 6 feet. That at a point 18 inches up stream from the lower end of said flume, a square-edged plank 6 inches in width shall be placed vertically at right angles to the side of said flume and 1 foot above the bottom, forming thereby beneath the plank an aperture of a parallelogram form one foot in height by the width of the flume, or the length required under the head of 12 inches to measure the number of Birmingham standard square feet of water which said —— is or shall be entitled to draw and use; the flume to extend up stream beyond the cross-plank a distance equal at least to once and one-half the width of the flume, and whenever the water discharged through the tail-race shall fill the aperture beneath the plank and the surface of the water shall be level with the top of the cross-plank, the water having a free flow from the end of the flume, then the quantity discharged will be the quantity that said —— or assigns is or shall be entitled to draw.

Directions are then given in the leases for measuring fractional parts of the amount the lessee is entitled to draw; and for measuring the flow in the tail-race by another method.

The next use of power is at Ansonia, a borough of 3,900 inhabitants. The privilege is owned by the Ansonia Land & Water Power Company. The dam is above the village, and is built diagonally across the river in a somewhat irregular line between abutments of rubble masonry. It is a timber structure, with a sloping face planked and having projecting ribs. The bulkhead is of timber with masonry side walls, between which the width is about 20 feet. The canal runs down the east bank of the river to the village, where the mills are located; it is

some 2 miles long, varies from 50 to 100 feet in width most of the way, and from 5 to 7 feet in depth. In part of its course it widens out so that with the pondage above the dam there is an aggregate reservoir surface of probably 80 acres or more.

The entire "head and fall" on this privilege is about 33 feet. Water is drawn from the canal in flumes under a full head of 30 inches, a square foot of water under that head constituting the standard square foot here, and being estimated to produce 30 theoretical horse-power. The privilege is assumed to yield 20 square feet of permanent water and 30 of surplus. Permanent water is considered to be worth $600 per annum per square foot, and surplus water from $250 to $500 per annum per square foot. The leases are said to be loosely drawn so far as regards defining the amount of water that may be used, and accurate measurements are not attempted. The brass companies are the principal owners in the water-power company, and are said practically to manage the water as they please. It is even reported that one company has extended its flume out under and then up into the bottom of the canal.

The ordinary power of the privilege is fully in use; in fact, most of the concerns, being of large size, use steam as well as water, the former being probably the more important source of power here. By the enumerators' returns a total of 1,600 horse-power of wheels was in use in 1880. All the permanent water, and two-thirds of the surplus, have been leased, as follows:

Lessees of water at Ansonia.

Company.	Permanent water.	Surplus water.	Remarks.
	Square feet.	*Square feet.*	
The Ansonia Brass & Battery Company	13	10	Uses steam and water. Manufactures sheet-, bolt-, and ingot-copper, sheet brass, brass and copper wire, etc.
Wallace & Sons	3	3	Use more steam than water-power. Manufacture sheet brass and brass goods.
The Osborn & Cheesman Company	2	2¾	Uses both steam and water. Manufactures sheet brass and brass goods.
The Farrell Foundery & Machine Company	1	2	Uses both steam and water. Very extensive works.
The Slade Woolen Company	1	2	Not in operation.
J. B. Gardner	.....	1	Manufactures clock-cases.
R. R. Colburn	.....	1	
	20	21¾	

At Seymour, the next manufacturing point, about 3 miles above Ansonia, there are two water-privileges on the Naugatuck. The lower is considered equal to about 20 square feet of permanent water, and is owned by the following concerns:

The J. H. Tingue Manufacturing Company, plush goods, 1 square foot; Carlos French, springs, 2 square feet; the United States Pin Company, 2 square feet; the Humphreysville Manufacturing Company, augers and bits, 3 square feet; the New Haven Copper Company, 12½ square feet.

The fall on the privilege is 18 feet. Sufficient water is obtained for the supply of the mills nine months in the year, but the stream runs very low in summer. No attempt is made to measure the water used. For this power a great outcropping ledge forms a natural dam stretching half-way across the river. The rest of the way the dam is artificial, and is built of stone upon a rock foundation. This portion is about 175 feet long, and contains three arched openings with gates for drawing down the pond. A timber bulkhead admits water to a short race leading to the various mills.

The upper privilege is owned by the Rimmon Water Company and embraces 18 feet fall. The flow of the stream is nominally divided into twelfths and is sold at such prices as may be agreed upon, there being no fixed rate. All the permanent power has been disposed of. The dam is in two straight sections forming something more than a right angle, one section having a sloping face and the other a vertical one. It is a fine structure of stone, and is supplemented by an embankment, giving a total length of perhaps 1,250 feet, including the 250 feet of roll-way. The abutments are of rubble masonry, and rise 8 feet above the crest of the dam. Above the latter is a pondage of about 115 acres. A small race leads down the east bank to W. W. Smith's manila paper-mill, where 14 feet head and 90 horse-power are in use. In dry seasons this mill is short of water from six weeks to three months. The main race is on the west side of the river, and supplies the Seymour Manufacturing Company, manufacturer of brass and German silver and lessee of one-half the flow of the stream; also the Fowler Nail Company, manufacturer of horseshoe nails and lessee of one-quarter the flow. In the summer of 1881 these concerns were somewhat short of water for about two weeks, but have not been troubled in that way at any other time. In 1880 a total of about 700 horse-power of water-wheels was in use at the two privileges here described.

At Beacon Falls the Home Woolen Company has been in operation about two years; it runs 18 sets of cards and employs 275 hands in the manufacture of fancy cassimeres. The dam is a low structure, presenting an angle up stream, and abutting against masonry at the east end and a natural ledge at the west. A long race leads perhaps half a mile down to the mill, where the fall is 22 feet. Since starting, the mill has always had sufficient water for running at full capacity.

Between Beacon Falls and the mouth of Beacon Hill brook, a distance of about a mile and a half, the valley of the Naugatuck is much of the way very narrow, being shut in by high hills with rocky precipitous slopes.

The fall is rapid over a gravelly bed. The railroad follows the west bank, and would probably be in danger of overflow if a high dam were built. Above Beacon Hill brook the valley is more open again, though its width is nowhere great. In the 3 miles between Beacon Falls and Naugatuck village it is probable that two fair powers might be developed.

The lower privilege at Naugatuck is owned by Lauren Ward, and occupied by L. & W. Ward in the manufacture of various small brass goods. The establishment is small, and but little power is used—as estimated, not over one-quarter the amount available. A low wooden dam, 180 or 190 feet long and 18 or 20 inches high, diverts water into a race leading to the shop, where it is used on an old-fashioned scroll-wheel running under a head of 5 feet.

It is said that a survey has shown the fall from the top of Ward's dam down to the mouth of Beacon Hill brook to be 16 feet, the power corresponding to which is estimated as below:

Estimated power between Naugatuck and Beacon Hill brook.

Stage of river.	RAINFALL ON BASIN.					Drainage area.	Flow per second, average for the 24 hours.	Theoretical horse-power.		
	Spring.	Summer.	Autumn.	Winter.	Year.					
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Sq. miles.*	*Cubic feet.*	*1 foot fall.*	*(a) 5 feet fall.*	*16 feet fall.*
Low water, dry year	10½	13½	12	10	46	240	70	8.0	40	130
Low water, average year							90	10.2	50	160
Available 10 months, average year							180	20.4	100	330

a A few horse-power already in use under this fall, as noticed above.

The upper privilege at Naugatuck is improved by a log dam 5 or 6 feet high, from which a race from one-third to one-half of a mile in length runs to the mills. The Goodyear's Rubber Manufacturing Company and the Goodyear's India Rubber Glove Manufacturing Company, practically one concern, have 12 feet fall and own 5 square feet of permanent water, the whole privilege being reckoned at 9 square feet; they also own all the surplus water. These concerns run two water-wheels, one of 80 and one of 40 horse-power, and have sufficient water for them about 8 months in the year. The remaining 4 square feet of permanent water is owned by the Tuttle Manufacturing Company, manufacturer mainly of hoes, rakes, and forks.

Between Naugatuck and Platt's mills there is some fall unimproved, probably enough at least for one good privilege.

Two-thirds of the next privilege is owned by the Platt Mills Company and the power used for a grist-mill; and one-third by Platt Brothers & Co., manufacturers of buttons. A timber dam with a stone apron runs in an irregular line across the stream, and a long race leads thence to the mills, where there is a fall of 17 feet.

Between Platt's mills and Waterbury there is one unimproved privilege (available fall said to be 14 feet), owned by the heirs of the late Merritt Nichols.

Estimate of power at the Nichols privilege.

Stage of river.	Drainage area.	Flow per second, average for the 24 hours.	Theoretical horse-power.	
	Sq. miles.	*Cubic feet.*	*1 foot fall.*	*14 feet fall.*
Low water, dry year	212	60	6.8	100
Low water, average year		80	9.1	130
Available 10 months, average year		160	18.2	250

The next power is the lower one at Waterbury. It is situated above the mouth of Mad river, and is occupied by the extensive brass, German-silver, and copper rolling- and wire-mills of the Benedict & Burnham Manufacturing Company. This concern uses 8 feet fall and a 40 horse-power wheel, for which there is always water enough.

The upper privilege at Waterbury is occupied by the Waterbury Brass Company, manufacturers of brass, gilding-metal, copper, and German silver. Water-power is here used from both the Naugatuck and Mad rivers, and steam-power in addition. The dam on the Naugatuck is of crib-work filled with stone, 150 feet long and 5 feet high. Water is brought to the mill a mile and a half in a race, which enlarges at points so as to give in the aggregate considerable pondage. A fall of 16 feet is obtained, and power is taken from a 50 horse-power turbine and a 125 horse-power breast-wheel. Both wheels can be run for not over six months in the year, but there is always water enough for the turbine alone.

The principal powers above on the Naugatuck, so far as could be learned, are at Thomaston and Wolcottville. At the former point the Seth Thomas Clock Company has large works. At Wolcottville the Coe Brass Company has 27 feet fall and 150 horse-power. The dam at this privilege was built in 1866 and cost about $18,000; it is constructed of timber and stone and is 96 feet long and 18 feet high.

Mad river, the most important tributary of the Naugatuck, furnishes several valuable powers in the city of Waterbury, with large falls ranging from 28 to 42 feet. The principal users of power in 1880 were the Waterbury Brass Company, Rogers & Brother (cutlery), the Scoville Manufacturing Company, the American Suspender Company, and the Benedict & Burnham Manufacturing Company. The Scoville Company has 42 feet fall and 250 horse-power. The company estimates that the full amount can be realized four months in the year, one-half capacity for an additional four months, and for the remaining four months only about one-quarter capacity.

THE SHEPAUG RIVER.

This stream rises in the town of Goshen, Litchfield county, Connecticut, flows southerly through the county, and in the western part of the town of Southbury unites with the Housatonic. Its drainage basin includes 153 square miles. In the town of Washington there is received, from the east, Bantam river, a short stream heading in Bantam lake, which contains 1,000 or 1,200 acres. The Shepaug railroad runs up the valley of the main stream from its mouth, and then follows up Bantam river and passes on to Litchfield. The Shepaug river runs over a gravelly bed and between banks of moderate height. The fall is rapid both in this stream and in the Bantam river, but the supply of water seems to be small in the dry season, and the only use of power is by a few saw- and grist-mills and one or two shops.

Table showing the fall in the Bantam and Shepaug rivers.

Locality.	Distance from mouth.	Elevation above tide.	Fall between points.	Distance between points.	Fall per mile between points.	Remarks.
	Miles.	*Feet.*	*Feet.*	*Miles.*	*Feet.*	
Bantam lake	25½	883	401	25½	30.5	The elevations here given are furnished by Mr. E. B. McNeill, civil engineer, of Litchfield. He also states that at Bantam there is a fall of 108 feet in 3,500 feet.
Washington	16	482	172			
Roxbury	6½	310	205			
Mouth of Shepaug	0	105				

Table of power utilized on the Housatonic river and tributaries.

Stream.	Tributary to what.	State.	County.	Kind of mill or manufacture.	Number of mills.	Total fall utilized.	Total water-power utilized.	Auxiliary steam-power.	Remarks.
						Feet.	*H. P.*	*H. P.*	
Housatonic river	Long Island sound.	Connecticut	Fairfield	Brass	1	Fall at mills, 22 feet.			
Do	do	do	do	Corsets	1		8		
Do	do	do	do	Cotton	1		250		
Do	do	do	do	Dippers and hollow-ware	1				
Do	do	do	do	Electro-plating	2		40+		
Do	do	do	do	Food preparations	1		4		Birmingham: Total horse-power of wheels in use in 1880, as returned by census enumerators and here detailed, 946. In the fall of 1882 the power in use was stated to be about 1,500 effective horse-power by day and 500 by night.
Do	do	do	do	Hardware, carriage	1		80		
Do	do	do	do	Horseshoes	1				
Do	do	do	do	House-furnishing goods	1		5		
Do	do	do	do	Iron nuts, bolts, washers, and rivets.	2		110		
Do	do	do	do	Needles and pins	1		30		
Do	do	do	do	Paper	1		300		
Do	do	do	do	Saw	1		35		
Do	do	do	do	Toys	1				
Do	do	do	do	Wood turning and carving	1		4		
Do	do	do	do	Woolen	1		80		
Do	do	do	New Haven	Saw and cider	1				Little York.
Do	do	do	Litchfield	Flouring and grist	1	7	150		New Milford.
Do	do	do	do	Iron furnace	1	8	90		Kent.
Do	do	do	do	Flouring and grist	1				
Do	do	do	do	Cutlery and edge-tools	1	13	60		West Cornwall.
Do	do	do	do	Flouring and grist	1				
Do	do	do	do	Iron foundery	1				
Do	do	do	do	Machinery	1	11–13	180		Falls Village.
Do	do	Massachusetts	Berkshire	Blacksmithing	1	10	10		
Do	do	do	do	Cotton	2	10, 10	264		Monument Mills, Great Barrington.
Do	do	do	do	do	1	14	100		Pittsfield.
Do	do	do	do	Flouring and grist	6	103	281	20	
Do	do	do	do	Paper	15	233	2,920	1,694	

Table of power utilized on the Housatonic river and tributaries—Continued.

Stream.	Tributary to what.	State.	County.	Kind of mill or manufacture.	Number of mills.	Total fall utilized.	Total water-power utilized.	Auxiliary steam-power.	Remarks.
						Feet.	*H. P.*	*H. P.*	
Housatonic river	Long Island sound	Massachusetts	Berkshire	Saw	8	121	235	.....	
Do	do	do	do	Woolen	10	166	1,198	695	
Naugatuck river	Housatonic river	Connecticut	New Haven	Bolts	1	12	60	.....	Birmingham: Total power in use in 1880, as here enumerated, 590 horse-power, water; 529 horse-power, steam.
Do	do	do	do	Corsets and supplies	2		22	75	
Do	do	do	do	Fancy articles	1		5	3	
Do	do	do	do	Flouring and grist	1		60	.....	
Do	do	do	do	Furniture	1		20	.....	
Do	do	do	do	Hosiery	1		90	80	
Do	do	do	do	Iron and steel	1		20	250	
Do	do	do	do	Machinery	1		150	80	
Do	do	do	do	Organs	1		60	.....	
Do	do	do	do	Pins	1		36	24	
Do	do	do	do	Tools	2		20	7	
Do	do	do	do	Toys and games	2		39	10	
Do	do	do	do	Wood turning and carving	1		8	.....	
Do	do	do	do	Brass and copper, rolled	3	Fall at mills, from 28 to 32 feet.	1,080+	1,662+	Ansonia: Total power in use in 1880, as here enumerated, 1,600 horse-power, water; 2,227 horse-power, steam.
Do	do	do	do	Clocks	1		40	30	
Do	do	do	do	Clock materials	1		30	80	
Do	do	do	do	Cotton	1		40	50	
Do	do	do	do	Hardware	1		5	5	
Do	do	do	do	Hosiery	1		60	.....	
Do	do	do	do	Leather belting and hose (?)	1		25	25	
Do	do	do	do	Machinery	1		120	100	
Do	do	do	do	Wire	1		200	275	
Do	do	do	do	Brass and copper, rolled	2	Two privileges, each of 18 feet fall.	340	200	Seymour: Total water-power in use in 1880, as here enumerated, about 700 horse-power.
Do	do	do	do	Blacksmithing	1		5	.....	
Do	do	do	do	Nails	1		100	.....	
Do	do	do	do	Needles and pins	1		30	.....	
Do	do	do	do	Paper	1		90	.....	
Do	do	do	do	Plush	1		.....	.....	
Do	do	do	do	Springs	1		.....	.....	
Do	do	do	do	Tools	1		35	.....	
Do	do	do	do	Vulcanized rubber (?)	1		100	.....	
Do	do	do	do	Woolen	1	22	.....	.....	Beacon Falls.
Do	do	do	do	Small brass goods	1	5	7	.....	Naugatuck.
Do	do	do	do	Rubber and elastic goods	1	12	120	120	Do.
Do	do	do	do	Agricultural implements	1		150	80	Do.
Do	do	do	do	Flouring and grist	1	17	145±	.....	Platt's mills.
Do	do	do	do	Buttons	1				
Do	do	do	do	Brass and copper, rolled	a 1	8	40	.....	
Do	do	do	Litchfield	Boxes, wooden packing	2	30	80	.....	
Do	do	do	do	Brass and copper, rolled	1	27	150	400	Wolcottville.
Do	do	do	do	Carriage and wagon materials.	1	3	12	.....	
Do	do	do	do	Clocks	1	11 22 24	107	185	Thomaston.
Do	do	do	do	Cutlery and edge-tools	1	8	18	.....	
Do	do	do	do	Flouring and grist	3	60	65	.....	
Do	do	do	do	Furniture	1	10	12	.....	
Do	do	do	do	Hardware	1	22	50	40	
Do	do	do	do	Paper	1	10	50	.....	
Do	do	do	do	Saw	10	144	263	.....	Mainly in Harwinton and Torrington.
Do	do	do	do	Wheelwrighting	1	15	15	.....	
Mad river	Naugatuck river	do	New Haven	Brass and copper, rolled	3	104	755	1,020	
Do	do	do	do	Brassware	1	39	60	40	
Do	do	do	do	Britannia and plated ware	1	20	80	150	
Do	do	do	do	Cutlery and edge-tools	1	28	55	.....	
Do	do	do	do	Paper	2	114	110	.....	
Do	do	do	do	Rubber and elastic goods	1	14	120	180	
Do	do	do	do	Tannery	1	13	40	.....	
All other tributaries.	do	do	do	Brassware	1	40	40	75	
Do	do	do	do	Buttons	3	84	75	30	

a Another mill is supplied partly from the Naugatuck and partly from Mad river, having 16 feet fall on the former stream.

Table of power utilized on the Housatonic river and tributaries—Continued.

Stream.	Tributary to what.	State.	County.	Kind of mill or manufacture.	Number of mills.	Total fall utilized.	Total water-power utilized.	Auxiliary steam-power.	Remarks.
						Feet.	*H. P.*	*H. P.*	
All other tributaries.	Naugatuck river	Connecticut	New Haven	Carpentering	1	.....	30	4	
Do	do	do	do	Carriage and wagon materials.	2	32½	25	40	
Do	do	do	do	Clocks	1	60	30	70	
Do	do	do	do	Cutlery and edge-tools	5	114	153	50	
Do	do	do	do	Electrical apparatus and supplies.	1	26	150	40	
Do	do	do	do	Fancy articles	2	37	21	.....	
Do	do	do	do	Files	1	15	3	.....	
Do	do	do	do	Flouring and grist	1	16	20	.....	
Do	do	do	do	Hardware	2	46	20	12	
Do	do	do	do	Hosiery	2	53	50	110	
Do	do	do	do	Machinery	1	22	30	.....	
Do	do	do	do	Needles and pins	2	82½	48	.....	
Do	do	do	do	Paper	1	24	45	32	
Do	do	do	do	Rubber boots and shoes	1	57	400	350	
Do	do	do	do	Saw	4	53	68	.....	
Do	do	do	do	Tools	2	32	116	30	
Do	do	do	do	Umbrellas and canes	1	14	8	.....	
Do	do	do	do	Upholstering	1	15	10	.....	
Do	do	do	do	Wood turning and carving	1	20	18	.....	
Do	do	do	Litchfield	Carpentering	1	26	6	.....	
Do	do	do	do	Cutlery and edge-tools	4	76	80	25	
Do	do	do	do	Flouring and grist	2	50	47	.....	
Do	do	do	do	Hardware	2	33	24	.....	
Do	do	do	do	Hooks and eyes	1	12, 16	75	40	
Do	do	do	do	Saw	3	78	87	.....	
Do	do	do	do	Silk	1	10	25	30	
Do	do	do	do	Sporting goods	1	28	14	.....	
Do	do	do	do	Umbrellas and canes	1	21	23	25	
Do	do	do	do	Wheelwrighting	1	30	27	18	
Do	do	do	do	Wood turning and carving	1	22	4	.....	
Do	do	do	do	Woolen	1	12	80	80	
Pomperaug river and tributaries.	Housatonic river	do	New Haven	Flouring and grist	2	19	70	.....	
Do	do	do	do	Saw	1	12	50	.....	
Do	do	do	do	Woolen	1	16	18	.....	
Do	do	do	Litchfield	Carriages and wagons	1	16	16	.....	
Do	do	do	do	Flouring and grist	3	58	46	.....	
Do	do	do	do	Paper	1	16	30	.....	
Do	do	do	do	Saw	3	38	60	.....	
Do	do	do	do	Sporting goods	1	14	15	.....	
Do	do	do	do	Woolen	3	38	66	40	
Shepaug river and tributaries.	do	do	do	Carriages and wagons	2	27	44	.....	
Do	do	do	do	Cutlery and edge-tools	1	16	25	.....	
Do	do	do	do	Cigars	1	.....	4	.....	
Do	do	do	do	Cotton	1	18	51	.....	
Do	do	do	do	Files	1	20	10	.....	
Do	do	do	do	Flouring and grist	6	99	208	.....	
Do	do	do	do	Iron castings	1	8	4	.....	
Do	do	do	do	Kaolin and ground earths	1	18	12	.....	
Do	do	do	do	Saw	6	92	347	.....	
All other tributaries.	do	do	New Haven	Flouring and grist	1	7⅛	12	.....	
Do	do	do	do	Sashes, doors, and blinds	1	18	10	.....	
Do	do	do	do	Saw	3	35+	65	.....	
Do	do	do	do	Wood turning and carving	1	20	10	.....	
Do	do	do	Fairfield	Belting and hose, rubber	1	41	500	250	
Do	do	do	do	Butter and cheese	1	10	10	10	
Do	do	do	do	Buttons	2	26	16	19	
Do	do	do	do	Carriage and wagon materials.	1	17	17	15	
Do	do	do	do	Churns	1	.....	4	.....	
Do	do	do	do	Combs	1	30	20	40	
Do	do	do	do	Cutlery and edge-tools	1	12	35	.....	
Do	do	do	do	Flouring and grist	12	187	254	.....	

Table of power utilized on the Housatonic river and tributaries—Continued.

Stream.	Tributary to what.	State.	County.	Kind of mill or manufacture.	Number of mills.	Total fall utilized.	Total water-power utilized.	Auxiliary steam-power.	Remarks.
						Feet.	*H. P.*	*H. P.*	
All other tributaries.	Housatonic river	Connecticut	Fairfield	Hardware	1	22	40	.....	
Do	do	do	do	Hat and cap materials	3	28+	87	120	
Do	do	do	do	Paper	2	32	105	55	
Do	do	do	do	Sashes, doors, and blinds	1	10½	12	5	
Do	do	do	do	Saw	14	246	166	.....	
Do	do	do	do	Wheelwrighting	2	33	16	.....	
Do	do	do	Litchfield	Agricultural implements	3	48	22	.....	
Do	do	do	do	Blacksmithing	1	8	10	.....	
Do	do	do	do	Chewing-tobacco	1	21	15	.....	
Do	do	do	do	Cutlery and edge-tools	2	39	37	40	
Do	do	do	do	Flouring and grist	18	348	507	.....	
Do	do	do	do	Furniture	1	.....	17	.....	
Do	do	do	do	Iron castings	2	29	35	.....	
Do	do	do	do	Iron and steel	5	92	383	60	
Do	do	do	do	Machinery	2	70	31	.....	
Do	do	do	do	Marble and stone work	2	17	13	.....	
Do	do	do	do	Paper	2	38	97	.....	
Do	do	do	do	Sashes, doors, and blinds	4	68	74	.....	
Do	do	do	do	Saw	18	310+	331	.....	
Do	do	do	do	Silk	1	18	40	.....	
Do	do	do	do	Tannery	1	8	4	.....	
Do	do	do	do	Wheelwrighting	1	20	12	.....	
Do	do	do	do	Wooden handles	1	18	24	.....	
Do	do	New York	Dutchess	Carriages and wagons	1	3	10	.....	
Do	do	do	do	Flouring and grist	5	88	180	.....	
Do	do	do	do	Sashes, doors, and blinds	1	7	10	.....	
Do	do	do	do	Saw	5	85	72	.....	
Do	do	do	Columbia	Flouring and grist	1	11	30	.....	
Do	do	do	do	Saw	3	32	55	.....	
Do	do	Massachusetts	Berkshire	Agricultural implements	4	73	50	.....	
Do	do	do	do	Cordage and twine	1	11	30	.....	
Do	do	do	do	Flouring and grist	17	283	538	.....	
Do	do	do	do	Furniture	1	17	15	.....	
Do	do	do	do	Iron and steel	1	17	40	120	
Do	do	do	do	Kaolin and ground earths	1	4½	30	.....	
Do	do	do	do	Machinery	2	16	27	20	
Do	do	do	do	Paper	8	335	713	597	
Do	do	do	do	Plaster	1	13	50	.....	
Do	do	do	do	Saw	30	540+	700	32	
Do	do	do	do	Shoddy	1	11	32	25	
Do	do	do	do	Wood-pulp	2	33	70	30	
Do	do	do	do	Woolen	6	158+	678	610	

V.—THE NORWALK RIVER.

This is a small stream lying in the southwestern part of Connecticut, and emptying into Long Island sound below South Norwalk. Its course is mainly through the towns of Ridgefield, Wilton, and Norwalk; the drainage basin is 15 miles long, 5 miles wide in the broadest part, and includes about 58 square miles. The Danbury and Norwalk railroad follows the stream closely through the greater part of its length.

The country embraced within the water-shed of the Norwalk river has a hilly surface. The stream itself has a large fall, amounting to 826 feet from the extreme source to the mouth, but being without storage reservoirs it runs very low in the dry season; for eight or nine months in an average year most of the mills have water enough, but for two or three months in the summer season there is a very scanty supply, hardly more than enough some of the time, as stated at one mill, for washing wool. Severe winter weather also brings down the stream, and it is at times low for a month from that cause.

In the town of Ridgefield there is a small reservoir of perhaps a dozen acres which, years ago, when the mills were much smaller, was a substantial help to the stream, but it is regarded as of little consequence now, and no attention has been paid to it for 15 years.

It is claimed that 15 or 20 miles from the mouth—that is, in the upper waters—a reservoir might be constructed at a cost of $20,000 which would be sufficient to carry the mills through dry weather, but they are generally provided with steam-engines and make no active movement toward reservoiring the stream, although it is evident that the power could be much improved thereby.

On the Union Manufacturing Company's dam, 140 or 150 feet long, the depth in freshets is frequently 3 or 4 feet, and in extreme cases 5 feet. Ice forms 10 or 12 inches thick in the mill-ponds, but usually rots before going out.

The lowest privilege on the river is that of the above-mentioned company, at Norwalk. There was formerly a dam 5 or 6 feet high below this, but on account of backwater it was purchased by the Union company and abolished. This company manufactures felt cloth and has also 6 sets of cards on fancy cassimeres. The dam is of rubble masonry and has a rock foundation. The fall is 21 feet 6 inches. Power is derived from a 120 horse-power overshot and a 75 horse-power turbine wheel. In low water the supply is insufficient for running even the turbine, and a 200 horse-power double engine is employed.

The stream is rather flat above until we reach Winnipauk. There the first power is occupied by the Lounsbury & Bissell Company, manufacturer of felt goods, its works being equivalent to a 13-set woolen-mill. The dam is an old structure of cement rubble-work. The head used is 12 feet, under which a turbine of 80 or 90 horse-power is run about one-half the year, while for two or three months it cannot be operated at all.

Next in order are the Norwalk Mills, using 18 feet fall and manufacturing fancy cassimeres; they run 12 sets of cards. The dam is of cement rubble, the head-race 600 to 700 feet long, and the tail-race say 250 feet. Power is taken from an undershot wheel 22 feet 9 inches in diameter and rated at 180 horse-power; it can be run about nine months in the year, but steam is relied upon the remainder of the time.

The stream was not examined above this point; there were reported to be occasional small saw- and grist-mills above Winnipauk, but no concerns of importance except at Georgetown, where the Gilbert & Bennett Manufacturing Company uses power in the manufacture of wire cloth.

Table showing the fall in the Norwalk river.

Locality.	Elevation of water-surface above tide.	Fall between points.	Distance between points.	Fall per mile between points.
	Feet.	*Feet.*	*Miles.*	*Feet.*
Source of stream	826	426		
Branchville	400	25	12	50.5
Georgetown	375	155		
Cannon's	220	39		
Wilton	181	57		
South Wilton	124	20		
Norwalk Mills	104	24	12	18.3
Winnipauk	80	58		
Norwalk bridge	22	22		
Mouth of stream	0			

Table of power utilized on the Norwalk river and tributaries.

Stream.	Tributary to what.	State.	County.	Kind of mill or manufacture.	Number of mills.	Total fall utilized.	Total water-power utilized.	Auxiliary steam-power.
						Feet.	*H. P.*	*H. P.*
Norwalk river	Long Island sound	Connecticut	Fairfield	Sashes, doors, and blinds	2	17	22	.....
Do	do	do	do	Saw	2	23	60	.....
Do	do	do	do	Toys and games	1	26	100	.....
Do	do	do	do	Wire	1	9	10	.....
Do	do	do	do	Wirework	1	16	50	80
Do	do	do	do	Woolen	3	56½	455	445
Tributaries	Norwalk river	do	do	Flouring and grist	1	16	12	.....
Do	do	do	do	Saw	2	32	19	.....
Do	do	do	do	Wood turning and carving	1	10	18	.....

Table of power utilized on sundry small streams tributary to Long Island sound.

Stream.	Tributary to what.	State.	County.	Kind of mill or manufacture.	Number of mills.	Total fall utilized.	Total water-power utilized.	Auxiliary steam-power.
						Feet.	*H. P.*	*H. P.*
Mill river and tributaries	Long Island sound	Connecticut	New Haven	Cotton	1	8	40	80
Do	do	do	do	Fire-arms	1	34	150	.....
Do	do	do	do	Flouring and grist	1	8	30	.....
Do	do	do	do	Hardware	1	10	30	.....
Do	do	do	do	Iron forgings	1	9½, 20	62	.....
Do	do	do	do	Needles and pins	2	8+	18	.....
Do	do	do	do	Saw	a4	87	86	.....
Do	do	do	do	Silk	1	7	15	.....
Tributaries	Westport river	do	Fairfield	Buttons	4	54+	45	14
Do	do	do	do	Cutlery and edge-tools	1	.....	35	.....
Do	do	do	do	Flouring and grist	3	28½	106	.....
Do	do	do	do	Iron castings	1	.....	10	.....
Do	do	do	do	Mattresses and spring beds	1	4½	6	.....
Do	do	do	do	Paper	1	14	30	.....
Do	do	do	do	Trunks and valises	1	4½	12	.....
Do	do	do	do	Wheelwrighting	1	.....	3	.....
Various other small streams	Long Island sound	do	New London	Cotton	2	24	38	.....
Do	do	do	do	Flouring and grist	8	111	202	.....
Do	do	do	do	Saw	7	95	117	.....
Do	do	do	do	Wood turning and carving	1	10	6	.....
Do	do	do	do	Woolen	1	18	60	120
Do	do	do	Middlesex	Flouring and grist	4	74	100	.....
Do	do	do	do	Paper	2	42	100	70
Do	do	do	do	Saw	5	78½	69	.....
Do	do	do	New Haven	Agricultural implements	1	15	10	.....
Do	do	do	do	Boxes, cigar	1	20	5	.....
Do	do	do	do	Boxes, wood packing	1	26	25	10
Do	do	do	do	Britannia and plated ware	1	20	20	25
Do	do	do	do	Carriages and wagons	1	10	10	.....
Do	do	do	do	Flouring and grist	6	70½	70	.....
Do	do	do	do	Iron bolts, etc.	1	11	20	.....
Do	do	do	do	Matches	3	31	61	110
Do	do	do	do	Paper	4	67	200	375
Do	do	do	do	Printing and publishing	3	34+	6	.....
Do	do	do	do	Saw	6	88	127	.....
Do	do	do	do	Sporting goods	1	10	16	.....
Do	do	do	do	Tin-, copper-, and sheet-iron-ware.	1	10	10	.....
Do	do	do	do	Wheelwrighting	1	12	65	.....
Do	do	do	do	Window blinds and shades	1	18	6	8
Do	do	do	do	Wood turning and carving	1	10	18	.....
Do	do	do	do	Woolen	2	35+	44	25
Do	do	do	Fairfield	Carriages and wagons	1	13	8	.....

a On tributaries.

Table of power utilized on sundry small streams tributary to Long Island sound—Continued.

Stream.	Tributary to what.	State.	County.	Kind of mill or manufacture.	Number of mills.	Total fall utilized.	Total water-power utilized.	Auxiliary steam-power.
						Feet.	*H. P.*	*H. P.*
Various other small streams	Long Island sound	Connecticut	Fairfield	Children's carriages and sleds.	1	10	16	.....
Do	do	do	do	Cigars	1	14	15	.....
Do	do	do	do	Dye-woods, dye-stuffs, and extracts.	1	3	225	1,509
Do	do	do	do	Flouring and grist	15	182	386	.....
Do	do	do	do	Hats and caps	1	16	18	.....
Do	do	do	do	Hat and cap materials	1	12	30	.....
Do	do	do	do	Iron and steel	2	15	205	85
Do	do	do	do	Iron nuts, bolts, washers, and rivets.	1	40½	135	.....
Do	do	do	do	Machinery	1	.....	6	8
Do	do	do	do	Paper	3	56	130	.....
Do	do	do	do	Pumps	1	15	85	.....
Do	do	do	do	Saw	9	136	114	.....
Do	do	do	do	Tools	1	28	35	.....
Do	do	do	do	Wirework	2	21	26	.....
Do	do	do	do	Woolen	4	69	216	200
Do	do	New York	Westchester	Buttons	1	4	13	25
Do	do	do	do	Flouring and grist	7	128	174	.....
Do	do	do	do	Iron forgings	1	13	28	.....
Do	do	do	do	Lithographing	1	7	10	.....
Do	do	do	do	Saw	4	47+	73	.....
Do	do	Connecticut	Fairfield	Flouring and grist (a)	2	13	68	.....

a Tide-mills.

Summary of power utilized on streams

[From the Thames river on the east, to

	River.	COTTON-MILLS.			SILK-MILLS.			WOOLEN-MILLS.			PAPER-MILLS.		
		Number of mills.	Water-power utilized.	Auxiliary steam-power.	Number of mills.	Water-power utilized.	Auxiliary steam-power.	Number of mills.	Water-power utilized.	Auxiliary steam-power.	Number of mills.	Water-power utilized.	Auxiliary steam-power.
			H. P.	*H. P.*		*H. P.*	*H. P.*		*H. P.*	*H. P.*		*H. P.*	*H. P.*
1	The Thames river tributaries	82	16,422	5,001	10	143	22	58	5,044	1,735	13	1,307	60
2	The Connecticut river and tributaries	88	16,434	4,370	13	517	851	107	8,378	2,753	104	23,538	2,034
3	The Quinnipiac river and tributaries	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4	The Housatonic river and tributaries	6	705	50	2	65	30	23	2,120	1,425	34	4,460	2,378
5	The Norwalk river and tributaries	.....	.....	.....	.....	.....	.....	3	455	445	.....	.....	.....
6	All other streams	3	78	80	1	15	.....	7	320	345	10	460	445
	Total	179	33,639	9,501	26	740	903	198	16,317	6,703	161	29,825	4,917

With unimportant exceptions, the figures given in the table are based upon the census enumerators' returns,

NOTE.—The same remark may be made here that has already been made in connection with the table of utilized power on the of the mills running only at irregular intervals; and that, since paper-mills are usually operated night and day, the power credited to manufacturing industry should therefore really rank first, in the region we are considering, in respect to the extensive use of water-power.

It is also to be said that the item of "auxiliary steam-power" is introduced mainly to show the extent to which steam- and water-power for many of the mills enumerated, located on small streams, rely upon steam as an important, and even the major, portion of their regular

The division of *woolen-mills* includes also a few worsted-mills.

The division of *various metal-working establishments* comprises blacksmithing, lock- and gun-smithing shops, brass and iron founderies, britannia- and plated-ware, bronze statuary, clocks, coffin-trimmings, cutlery and edge-tools, dippers and hollow-ware, electrical apparatus nails, needles and pins, pumps, saws, screws, scales and balances, sewing-machines and sewing-machine materials, springs, steam fitting

The division of *various wood-working establishments* comprises carpentering, cooperage, wheelwrighting, and wood-turning and carving bobbins, canes, carriages and wagons, carriage and wagon materials, chairs, chair-stock, children's carriages and sleds, churns, coffins materials, rules, sashes, doors, and blinds, shoe-pegs, spools, washing-machines and clothes-wringers, wheelbarrows, wooden handles, and

The division of *sundry other establishments* comprises bleaching and calendering, dyeing and cleaning, electro-plating, lithographing, repairing shops, and establishments for the manufacture of baskets, rattan- and willow-ware, leather belting and hose, boots and shoes, chewing-tobacco, cigars, combs, cordage, corsets, drugs and chemicals, emery-wheels, explosives and fire-works, fancy and paper boxes whetstones, hosiery, horse-blankets, kaolin and ground earths, leather-board, linen, mattresses and spring beds, mosquito- and fly-nets, elastic goods, vulcanized rubber, rubber boots and shoes, rubber belting and hose, shoddy, soap and candles, spectacles, sporting goods, materials, wood-pulp, and wool extract.

tributary to Long Island sound.

the Bronx on the west, both inclusive.]

FLOURING- AND GRIST-MILLS.			SAW-MILLS.			VARIOUS METAL-WORKING ESTABLISHMENTS.			VARIOUS WOOD-WORKING ESTABLISHMENTS.			SUNDRY OTHER ESTABLISHMENTS.			TOTAL.			
Number of mills.	Water-power utilized.	Auxiliary steam-power.	Number of mills.	Water-power utilized.	Auxiliary steam-power.	Number of mills.	Water-power utilized.	Auxiliary steam-power.	Number of mills.	Water-power utilized.	Auxiliary steam-power.	Number of mills.	Water-power utilized.	Auxiliary steam-power.	Number of mills.	Water-power utilized.	Auxiliary steam-power.	
	H. P.	*H. P.*		*H. P.*	*H. P.*		*H. P.*	*H. P.*		*H. P.*	*H. P.*		*H. P.*	*H. P.*		*H. P.*	*H. P.*	
68	1,887	70	99	2,157	5	27	587	40	30	549	45	33	2,367	385	420	30,523	7,363	1
303	11,579	278	794	27,194	1,293	256	10,547	2,117	413	10,842	1,354	220	8,997	997	2,208	118,026	16,047	2
4	108	.....	7	217	.....	22	1,812	903	5	67	15	2	14	.....	40	2,278	918	3
82	2,614	20	110	2,528	32	96	5,747	5,210	36	557	77	53	2,363	1,502	442	21,159	10,724	4
1	12	.....	4	79	.....	2	60	89	3	40	.....	1	100	.....	14	746	525	5
46	1,136	.....	35	586	.....	20	885	118	13	223	128	16	396	1,539	151	4,099	2,055	6
504	17,396	368	1,049	32,761	1,330	423	19,638	8,468	500	12,278	1,619	325	14,237	4,423	3,365	176,831	38,232	

and represent the power in use in 1880.

Connecticut river and tributaries, namely, that the power credited to saw-mills, while large, is not all in continuous use, very many them should be largely increased in reckoning upon the same basis of daily working-hours common among other mills. The paper-

are combined in the same establishments, and is not to be taken as a proper measure of the deficiencies of the streams in the dry season; motive power, rather than merely as supplying the lack of power due to summer low water.

brass and copper rolling-mills, and establishments for the manufacture of agricultural implements, bells, bits and gimlets, brass-ware, and supplies, files, fire-arms, general hardware, hooks and eyes, horseshoes, iron forgings, iron bolts, nuts, washers, and rivets, machinery, and heating apparatus, stencils and brands, swords, tin-, copper-, and sheet-iron ware, watch and clock materials, wire and wirework.
shops, planing-mills, and establishments for the manufacture of billiard and bagatelle tables, cues and materials, cigar- and packing-boxes, and other undertakers' goods, excelsior, furniture, general house-furnishing goods, matches, models and patterns, picture molding, piano wooden ware.
marble and stone, calico printing, printing and publishing, soapstone, and wool-grading and scouring works; tanneries, watch- and clock-boot- and shoe-findings, bricks and tiles, brooms and brushes, butter and cheese, buttons, carpet yarns, crashes, twines, and bagging, and other fancy articles, fertilizers, food preparations, gloves and mittens, gunpowder, hats and caps and hat and cap materials, hones and mucilage and paste, musical instruments and materials, patent medicines and compounds, plaster, preserves and sauces, rubber and starch, stationery goods, tape, toys and games, trunks and valises, umbrellas, upholstering materials, vinegar, whips and lashes, whip

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TO

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